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Volume 36, Number 7 July 2006

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ON THE COVER

Farncomb Hill in Breckenridge, Colorado, is the best-known source for choice crystallized specimen gold. This 11.5-centimeter-high specimen is in the collection of Wayne Thompson. (Photo by Jeff Scovil)

Miller Magazines, Inc.

Rock & Gem (ISSN 0048-8453, USPS 486-290) is published monthly by Miller Magazines, Inc., 290 Maple Ct., Ste. 232, Ventura, California 93003-3517, telephone (805) 644-3824. Periodicals postage paid at Ventura, CA 93006, and additional mailing offices. Single-copy price $4.99. Subscription in U.S.A. and possessions: 1 year (12 issues) for $24.00; 2 years for $42.00; 3 years for $54.00. Add $15.00 per year postage for Canada and all other foreign countries. Submission of articles and photos by our readers is welcome, but we can accept no responsibility for loss or damage to unsolicited editorial contributions.

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Printed in U.S.A.

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Rock & Gem,
P.O. Box 469113, Escondido, CA 92046-9113
or RockAndGem@pcspublink.com

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COLORADO MINERALS

Part II:
Gold and Silver Lead the Way to Gems

Story and Photos by Bob Jones

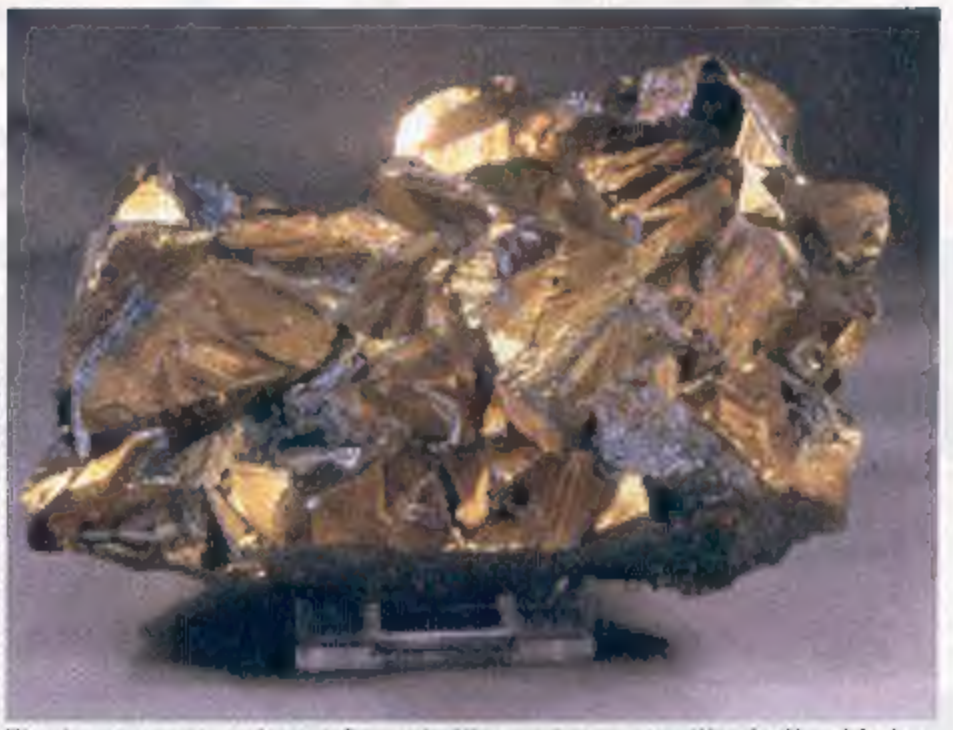
HARVARD COLLECTION

A 4½-inch ram's horn from Gilman and a wire gold specimen from Breckenridge represent two of Colorado's great gold deposits.

In Part I of this article, I described some of the world's finest specimens of rhodochrosite, just one of the great minerals that has come from Colorado's mines. Colorado has also been one of the most important sources of barite in the United States.

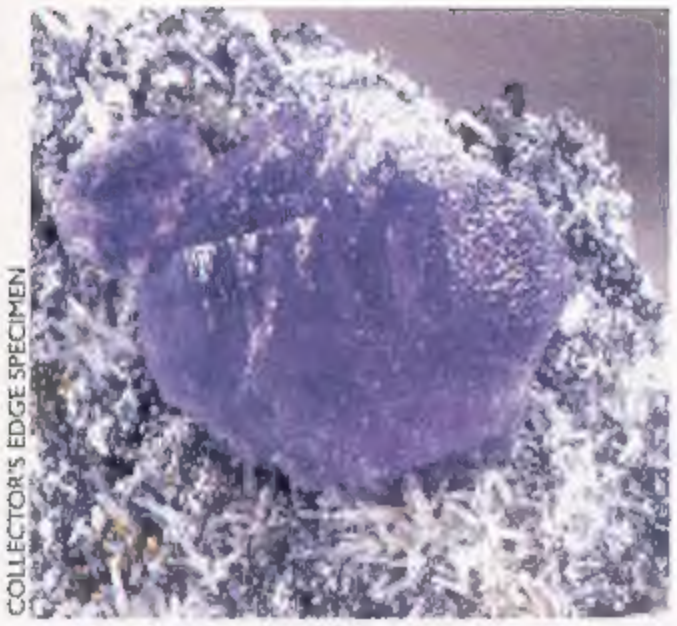
In Part II, I will discuss Colorado's gold and silver specimens, its historically important amazonite/smoky quartz pairs, and fine gangue minerals, including calcite and quartz, and some of the sulfides, which we seldom think of as exciting collector minerals.

The San Juan Mountains, in southwestern Colorado, are highly mineralized. Just take a look at the three Red Mountains, bright red because of the effects of weathering on their iron content. These mountains produced huge quantities of silver in their heyday.

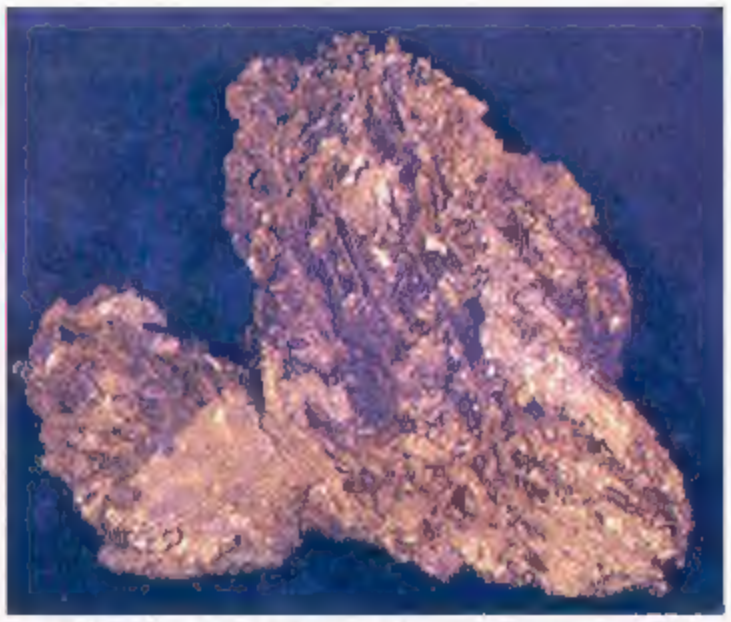


COLLECTOR'S EDGE SPECIMEN

The huge copper mine at Summitville produces covellite in fine blades.



The Sweet Home Mine produced very fine fluorite on occasion.



The crystalline Breckenridge gold specimen known as Tom's Baby weighs over 13 pounds.

A nice combination of smoky quartz, amazonite, and feldspar is typical of material from the Pikes Peak area.

Farncomb Hill produced some of Colorado's superb gold specimens, like this 5-inch-high group.

While silver ended up being the most important precious metal in Colorado, it was California gold that brought prospectors to this mountainous state. When the gold rush started, one way to get to California was through the rugged terrain of the Colorado Territory. One group of Georgia argonauts camped on Cherry Creek, near present-day Denver. They had panned for gold in the Southeast, where America had experienced its first gold rush, and it is not surprising that they found a bit of gold in the creek, but the lure of "streets of gold" kept them moving west. It was only after the California rush began to play out that these same prospectors remembered the Cherry Creek gold. Thus, gold prospecting and the resulting big strike in 1859 opened the door to the precious metal search in the Rockies that uncovered Leadville and a host of other silver-bearing regions.

Gold was also found in some quantity. Several gold mines, including the Sunnyside, the Camp Bird, the Idarado, Breckenridge, and the Gold King, produced plenty of gold, some of which was beautifully crystallized and worth collecting for display. Such mines also produced a variety of wonderful collector mineral species, as witnessed by the fine rhodochrosites from the Sunnyside.

While California has long held the top spot for crystallized gold, Colorado is a close second. Breckenridge is well known for its amazing crystallized gold. The Eagle Mine in Gilman, Colorado, has produced the world's finest ram's horn gold specimen ever found in America. The ram's horn is still in existence.

The search for gold and silver opened the earth for mines and enabled collectors to find superb calcites and quartzes, some of the nicest found in the United States. Not only do calcite and quartz occur here in discrete and sometimes spectacular crystal clusters, in a couple of mines they also occur as casts after minerals like fluorite. Such crystal casts are particularly interesting to collectors.

The Idarado Mine is probably the best-known Colorado source for fine calcite and quartz specimens. Located between Ouray and Silverton in the San Juan Mountains, the Idarado is right across the valley from the Red Mountain group. It is also on the other side of the mountains from Telluride, a very productive silver region that is now famous for its ski resorts.

The San Juan Mountain area is one of the most scenic areas in America. Nearby Ouray is called "The Switzerland of America" for good reason. The snow-capped mountains, deep gorges, and rugged landscape are attractive no matter what time of year you visit. The road between Ouray and Silverton is called "The Million Dollar Highway," as the fill used for the road bed often came from old mine dumps, created back in the days when the silver extraction process left a high percentage of silver in the dump rock!

The Red Mountains are richly colored by iron oxide. After a rainfall, they are a particularly lovely orange-red. These mountains were heavily mined for gold and silver in the late 1800s and early 1900s. The Idarado Mine operated until the 1980s as a rich gold producer.

During and after gold mining, the Idarado was a wonderful source of snow-white, opaque quartz crystals and fine calcite. Many of the Idarado quartz crystals bulge slightly, as their curving prism faces make them fatter in the middle than at the base and termination. The quartzes have often been found in clusters, sometimes with other minor minerals attached. They often have an overgrowth of quartz on quartz. Most crystals are a few inches long, with larger ones found occasionally.

Some of the Idarado quartzes formed on dog-tooth calcite crystals. Later solutions dissolved away the calcite, leaving the hollow shell cast of the quartz. These are highly prized as excellent examples of a cast mineral. The quartz casts are always a stark, sparkling, snowy white.

Other attractive quartz casts occur in this region, most commonly after cubic fluorite. In a few cases, the quartz did not completely cover the fluorite, resulting in an image of the fluorite cubes with open "windows," through which you can see into the hollow silicon dioxide casts.

The Idarado calcites are excellent, usually in dog-tooth groups with crystals ranging from an inch to several inches long. The larger crystals can reach 4 inches. Some groups are more than a foot across and often have a faint pinkish tinge to them, due to a trace of manganese carbonate in them. These are referred to as manganocalcite, an accurate term if the manganese content is high enough. Under short-wave ultraviolet light, these calcites glow a strong red due to the manganese activator. Large plates, a foot or more across, composed of 1-inch calcite crystals are not unusual here.

continued on next page

The Idarado Mine is easily seen as you drive the snakelike road from Ouray to Silverton. The long shed that covers the tracks going to the dumping area is right next to the highway.

Another good producer of quartz crystals in the San Juan Mountains is the Camp Bird Mine, located at the foot of Imogene Pass, not far from Ouray. This pass is easily traversed by four-wheel-drive and connects Ouray with Telluride. The Camp Bird was basically a gold producer. It also produced fine quartz, excellent calcites, interesting small sphalerites, and other minerals.

Imogene Pass is a delightful drive if you ever have a chance to take it. As you climb above the Camp Bird, you can look down on the mine buildings. Farther along, close to the summit from the Ouray side, there is a turnoff to the left that takes you to an overlook. This is the perfect place to view the Red Mountains in all their colorful glory. With a background of dark volcanic peaks, these red peaks stand out in stark, bright color, one of this country's great mountain views.

The Camp Bird has quite a history. Initially, it was not much of a gold producer, but the veins of quartz were useful as a flux material in smelters, so Tom Walsh bought the Camp Bird for that purpose. Little did he know that, in the continuous digging of the quartz, he would strike rich gold veins that would make him a millionaire several times over.

Colorado's most famous quartzes are the smoky prisms from the Pikes Peak area. These lovely crystals occur in so many places that filing claims and mining for specimens have become an industry. Pikes Peak smoky quartz has been collected for over 150 years. Anyone walking the slopes of this 14,000-foot peak might come across a crystal that has weathered out of the granite. It is rife with small to fairly large pegmatite pockets, often loaded with fine, gemmy smoky quartz crystals, choice blocky microcline (variety amazonite), small purple fluorite cubes, mahogany-colored sprays of flat goethite crystals, and, rarely, a small topaz crystal.

The quantity and quality of Pikes Peak quartz is immense and is literally endless because of the huge number of pockets and crystal-lined seams yet to be discovered. Mining here is an almost continuous effort on dozens of claims, so the supply of amazonite/smoky quartz is steady.

The Pikes Peak quartz crystals can range in size from under an inch to over a yard long. Some are doubly terminated, but most rest on a feldspar amazonite matrix. The really large crystals tend to have rough prism faces with all sorts of growth patterns. The prism faces are often slightly curved, making the crystals appear slightly fatter in the center. The majority of the crystals, however, often have smooth prism faces with only minor growth patterns. Most have perfect terminations and are usually tapered, sometimes very dramatically. The color ranges from good smoky to extremely dark smoky. Most are gemmy. When free-standing, like some regal prism on a cluster of sharp, richly colored amazonites, these quartzes are literally breathtaking.

The amazonites are also remarkable and fairly common. They are usually reported to be microcline, which means they fall into the triclinic crystal group. Albite is commonly an intimate part of the crystals. This variety of feldspar can

Mount Antero has produced some very fine smoky quartz crystals.

form white caps on some crystals or may be seen as vertical white "bars" along the prism face of a crystal. Most commonly, albite is seen as small, white specks in the blue-green amazonite. This gives the amazonite a mottled look.

Many of the Pikes Peak amazonites are twinned, showing one of the three common twinning forms of feldspar. The amazonites tend to be intergrown in clusters. They are blocky, usually not highly lustrous, but often equidimensional, almost as broad as they are long. They are almost always sharp and well terminated, and when found with fine smoky quartz crystals, they create a perfectly lovely duet of contrasting crystal form and color.

Before serious specimen mining ever began here, the locals used to hike the trails on Pikes Peak and nearby slopes in the early spring and pick up any loose crystals that had been weathered out by frost and water action during the winter. My father-in-law, as a teenager during World War I, spent his summers in Ruxton Park on the side of Pikes Peak. He was one such crystal seeker and was reasonably successful each year.

Along the tracks of the Pikes Peak Cog Railway there was once a hotel called Halfway House because of its location. The ruins of that old hotel can still be seen from the Cog train. My grandfather told me that many of the guests at Halfway House enjoyed crystal walks. The mantle over the fireplace in the hotel was lined with quartz and amazonite crystal groups that had been picked up by guests!

Occasionally in the summer, we would ride the Cog train, get off at Halfway, and visit a nearby site that had been blasted for a new cabin. Construction never happened because Colorado Springs had taken over the Peak as a water supply area in 1907. Fragments of amazonite and quartz crystals were scattered about the cabin site where blasting had thrown them.

From the cabin site, we used to walk over to the pipeline, follow it, enjoying wonderful raspberries, then ride the Incline down to Manitou. Today, the Incline is nothing but a scar on the mountain slope, but I'll bet you can still find the odd quartz or amazonite if you make that hike.

On one trip up Pikes Peak, we visited Clyde McReynolds, who was caretaker for the Colorado City Water Authority. It was his job to keep folks from fishing the lakes and otherwise encroaching on the city's water supply. When I met Clyde, he was over 90 years old and still cutting his own grass at 9,000 feet with a hand mower! The mantle in his house was also nicely decorated with smoky quartz and amazonite crystals he had picked up as he performed his duties on the Peak.

With specimen mining in full swing in the Pikes Peak, Lake George, and Florissant areas, I see no reason fine smoky quartz and amazonite crystal groups won't continue to be supplied to collectors for years to come.

One of the minor associated minerals found in some amazonite pockets is fluorite in small purple cubes. These never constituted spectacular display specimens, but they add another dimension to the amazonite/smoky quartz story.

Fluorite is another fine collector mineral found in quantity in Colorado. Best known are the fluorites that occurred with pink rhodochrosite in the American Tunnel of the Sunnyside Mine, near Silverton, which I described in depth in Part I of this article.

These fluorites ranged from colorless to pale to good green. In crystal form, most were cubic, but some large, very fine octahedral fluorites also occurred in the American Tunnel. It is interesting to note that most of the colorless American

Tunnel fluorites that I have seen are on a quartz matrix that lacks any evidence of rhodochrosite. On the other hand, the green fluorite, again on quartz, is often associated with rhodochrosite crystals.

Fluorite was also found associated with the rhodochrosite from the Sweet Home Mine, which I described in Part I. Though fluorite is usually absent or only of minor importance on Sweet Home specimens, some of these fluorites are marvels of crystal form. Anyone interested in this calcium fluoride mineral would enjoy the Sweet Home crystals. They range in color from deep purple to colorless; they are sometimes blue and sometimes slightly zoned. The individual crystals are seldom large, usually well under an inch, but they tend to cluster to form small, colorful groups on quartz with rhodochrosite.

Octahedrons were also found regularly at the Sweet Home. They, too, are small, but sharp, and usually scattered in small clusters on quartz. Occasionally, a specimen was mined that had single fluorite cubes perched on the tips or sides of quartz or even rhodochrosite crystals. Such specimens are very uncommon and are almost never seen for sale.

Most interesting are the stacked and intergrown cubes of fluorite that have an overall octahedral form and, in some cases, a complex dodecahedral form. These can be dark purple and reach an inch or so in size. These were also highly prized and won't be seen for sale these days.

Another source of fluorite in Colorado is the type locality for the mineral creedite, Wagon Wheel Gap, near Creede. Here, the fluorite occurs in thick veins as massive ore and in vugs, where it crystallized in cubes. Most of the fluorite was a sugary, granular material, but fine cubes and an unusual botryoidal form of fluorite also occurred. The most unusual fluorite reported from the gap is called cone fluorite. The mineral actually takes a tapering, cone-shaped form covered with crystal faces. To me, they resemble fluorite pseudomorphs after dog-tooth calcite.

Rhodochrosite, gold, silver, fluorite, quartz, and calcite are not the only minerals that occur in the San Juan Mountains of Southwest Colorado. The Adams Mine and several nearby mines are well known as sources of fine heubnerites, which form as brown blades in diverging sprays of radiating clusters. Some of these crystals reach 6 inches in length. In strong light, the crystal edges show a fine red color. The Adams was collected by amateurs for decades and always produced something. During gold mining at the nearby Gold King Mine, huebernites were encountered, suggesting the area has more of this manganese tungstate for collectors to dig.

Old-time collectors will remember Ed McDole, an itinerate miner and dealer. Ed worked many a mine for specimens, which he would sell out of his car, always a black Lincoln. Ed frequently worked the Adams Mine when he was in Silverton, and died in his hotel room there, most likely of insulin shock. When he was found, there was a stack of beer flats full of recently collected huebnerites in his room. Those flats, along with the superb personal collection he had in his car, disappeared!

Copper minerals are not abundant in Colorado, with a couple of exceptions. Summitville, in Rio Grande County, has long been mined for covellite as an ore. Covellite is a copper sulfide that forms in lovely, bladed masses. The Summitville covellite occurred primarily in the Little Annie vein as a thick, nearly solid run of crystallized covellite. Such an occurrence is decidedly unusual, as covellite is one of the uncommon copper sulfides. Butte, Montana, is best known for this mineral.

Most of the copper sulfide from Summitville is massive, intergrown blades that are of little value as specimens. Serious damage on the crystal edges detracts from most specimens mined here. Because the crystals developed profusely, they crowded each other, packing close together and preventing free growth of the blades. The exception to this rule is small clusters of light-blue to indigo foliated blades to an inch or so high. These, when undamaged, make very attractive specimens. Some are lightly coated with chalcopyrite, which gives them a very attractive brassy or golden tint. The Denver Museum of Nature and Science has some lovely examples of Summitville covellite.

That same museum also has a gold specimen from the Summitville area that has an interesting story attached to it. When the mine at Summitville was operating, the road into the site needed widening, so the company hired a fellow with a bulldozer to do the job. As his blade gouged into the roadside, a huge boulder rolled off his blade and caught his eye. He was amazed to find the white quartz boulder was shot through with gold—lots of gold! Naturally, he wanted to get a good price for his boulder, and he called around looking for someone to appraise it. I was contacted, but I begged off as unqualified. He finally got an appraisal, and the gold boulder ended up at the Denver Museum.

continued on next page

The Longfellow Mine, in the Red Mountain district of the San Juan Mountains has also produced some interesting copper minerals. It produced very fine enargites, a copper arsenical sulfide, some of which were as good as those from Butte, Montana. The crystals are tabular and striated, and tend to be about an inch or so in length, with some reaching several inches. The terminations on these crystals are typically flat. In rare instances, the enargites formed trillings, three crystals sharing a common twinning plane.

Sphalerite is another sulfide that is found abundantly during silver mining in Colorado. This zinc sulfide can occur as ugly, black crystals, as bright-red, gemmy crystals, and as gemmy dark- to light-green crystals. Most Colorado sphalerite specimens are transparent and dark to light green. Many crystals from the gold and silver mines are small, seldom an inch on an edge. They occur in flat, crowded plates of crystals, usually with galena. Such specimens are typical from the Camp Bird and the big silver camp at Creede, which sits at the headwaters of the Colorado River.

Most Colorado sources produced only small sphalerite crystals, but the Big Four Mine in Summit County produced crystals to 4 inches on an edge. The Colorado sphalerites everyone would love to own are the green, gemmy crystals with protruding small, curling gold wires. These were found in several of the mines in the San Juan Mountains, including the Buffalo Boy and the Brooklyn Mine. These specimens are uncommon, I might even say rare. These gemmy green sphalerites with included gold are real collector classics!

One of the areas amateur collectors have worked for decades is Mount Antero, southwest of Leadville and overlooking the Arkansas River valley. This mountain was never mined for ore, but its pegmatites have been productive enough that claims have been filed and it is now being mined for specimens.

At least one of these pegmatites is producing huge quartz and feldspar crystals. By huge, I mean several feet long! One such pocket produced the largest such crystals ever found on Antero. While these big quartz crystals are attractive, the goal of all the diggers on Mount Antero is to find the blue aquamarine crystals that occur sparingly in the pegmatites.

For years, the Mount Antero aquamarines were brought out as small single crystals, usually an inch or two long. These earlier crystals range from nearly colorless to pale blue to good blue, never intense. Most crystals have striations running the length of the prism faces and show gemmy areas. A few have etched terminations. A fine selection of these interesting, but never exceptional, gem crystals can be seen on display at the Denver Museum.

All this changed a couple of years ago, when specimen miners unearthed a few fantastic specimens of aquamarines, the finest ever found in Colorado. In fact, these are the finest aquamarines ever found in America. They exceed anything I've ever seen from the far more famous pegmatite deposits in Maine and California.

The larger crystals in this find are nearly 6 inches long, excellent blue, clean, and gemmy. They are slightly thicker than a pencil, transparent, and gemmy. They perch jauntily on a feldspar and minor smoky quartz matrix. The last time I talked with people associated with this project, a move was underway to extract entire pockets of these lovely crystals so the pockets can be re-assembled for museum display. Let's hope it happens. Because of finds like this, mining for specimens on Mount Antero will continue for a long time.

COLLECTOR'S EDGE SPECIMEN

Aspen's mountains produced superb wire silver in tangled masses.

Another gem mineral found sparingly in Colorado is topaz. One of the better-known finds was made by Ed Over and Arthur Montgomery near Pikes Peak decades ago. Since that time, small, well-terminated, usually colorless topazes have been found while collectors dug for amazonite and smoky quartz. The crystals tend to be loose rather than on matrix.

As I said, many of the superb collector species that have been found in Colorado owe their discovery to gold and silver prospecting and mining. A good example is the Sweet Home Mine, source of the world's greatest rhodochrosites, which started as a silver mine, but never amounted to much.

Some of Colorado's silver and gold mines, while never as large and rich as Nevada's Comstock or California's Mother Lode, still are important in Colorado's history. The silver discovery at Creede spawned some interesting minerals and characters. Fine cutting-grade quartz/amethyst in alternating bands with silver and silver sulfides was common here, as were wire silver specimens. The mine also added to Colorado's barite fame by producing white blades to 6 inches on an edge. Plenty of sulfides like galena and green, gemmy sphalerite were also common from Creede at one time.

Creede's best-known character was the nefarious Soapy Smith, so named because he was so slick and slippery. Soapy and his gang ended up in Skagway when the Alaska gold rush began. Soapy's gang was adept at guiding neophyte gold prospectors into Soapy's clutches, where they were fleeced like so many lambs!

Of all the gold and silver mine regions in Colorado, Leadville was the richest silver mine area and one of the more notorious. Though you see very few silver specimens from Leadville's many mines, other of its minerals are highly prized. The Ibex and the Little Jonny produced superb cubes of pyrite, some of them as long as a foot on an edge. Most crystals are lustrous, sharp-edged, and very beautiful. One of the special types of Leadville pyrite has odd striations on the cube faces that form the curving, peaked pattern of a gothic window or doorway, hence the name "cathedral pyrite." These have been particularly popular with pyrite collectors.

The huge open-pit/underground mine at Climax also produced wonderful pyrites, sharp, shiny, smooth-faced cubes approaching 2 inches on an edge. The most important Climax pyrite specimens also have fine purple to violet fluorite cubes attached. Not many such specimens survived, but the suite of Climax rhodochrosite, fluorite and pyrite specimens is considered a real prize by Colorado species collectors.

Two other Colorado mining regions, Gilman and Rico, were also well known for their abundant production of striated pyrite crystals. Most crystals are around an inch on an edge and are in tightly intergrown groups. The Rico crystals were usually cubic, while the Eagle Mine at Gilman produced a huge abundance of solid plates of pyritohedrons, unusual crystals with five-sided crystal faces. Thousands of specimens of these pyrites were mined here and were available in quantity through the 1950s and 1960s.

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While Colorado never did produce a quantity of spectacular and finely crystallized silver specimens, largely due to the silver's occurrence in argentiferous galena and silver sulfosalts, it certainly is well known for its superbly crystallized gold. The best-known source for choice crystallized specimen gold has been Breckenridge, specifically Farncomb Hill. During mining here in the late 1800s, choice crystallized gold was extracted. One notable discovery was a 22-pound tangled mass of wire gold, which caused the development of the Wirepatch Mine on Farncomb Hill.

As underground mining proceeded here, an unusual type of gold was found. Instead of quartz, as in California, the host rock was a carbonate that had developed typical rhombic cleavage seams common in siderite, calcite, and the like. When the gold-bearing solutions invaded these rhombic seams in carbonate rock, it filled the cracks and took on their shape. The gold extracted in crystal groups here consists of thin septa of gold in beautiful rhombic configuration. The thin septa are covered with tiny octahedral crystals, which developed along with the thin-walled shapes. These are spectacular specimens. A few hundred specimens of this lovely gold have survived, largely in the Campion collection, which is now displayed in a glass-fronted vault at the Denver Museum of Nature and Science. John F. Campion was one of the owners of gold mines on Farncomb Hill and was obviously a lover of fine crystallized gold.

One of the great stories to come out of Breckenridge is about two contract miners who dug a mass of crystalline gold and were so excited with their find that they wrapped it in a blanket and touted it in every saloon in Breckenridge. It came to be dubbed "Tom's Baby." No one knows the trail that huge mass followed; in fact, it disappeared and was assumed to have been smelted along with most other Breckenridge gold.

When the Denver Museum started an inventory of its mineral collection, someone mentioned that there were two wooden crates of unknown items stored at the local bank. When the crates were opened, there were quantities of crystallized gold specimens belonging to the Campion collection that had once been on display, but had gone into storage at some point. In among the smaller gold specimens were two large masses which, when put together, proved to be the long-lost Tom's Baby. Though it had been broken and a small portion of it was gone, possibly lost when the original specimen was parted, the remainder was definitely Tom's Baby. This marvelous mass of crystalline gold now resides in a display case at the Denver Museum of Nature and Science. Harvard University's collection also contains some superb Breckenridge pieces, and there are some in private collections.

As famous as Breckenridge golds are, they are exceeded by a Colorado specimen that is generally agreed to be America's best surviving wire, or ram's horn, gold specimen. The specimen is 4½ inches long. It curls near the top and

The Idarado Mine produced superb quartz casts after calcite.

is about an inch thick at the base. Deep striations run the entire length of this amazing specimen. This world-famous gold did not come from Breckenridge, but from the Eagle Mine in Gilman, Eagle County, about 20 miles northwest of Leadville. It was probably mined in the 1920s, though there really is no record of when it reached the light of day. It first appeared in print in a black-and-white photograph and was labeled "silver" from the Eagle Mine! It is now in the Harvard collection and is displayed frequently at shows around the country.

Gold played a significant role in Colorado's history, as it was mined from the mid 1800s onward. For instance, Colorado gold led to this country's only verified case of cannibalism. A group of neophyte gold seekers hired Alferd Packer to guide them into the San Juans to find gold. They made the mistake of starting late in the year; once deep in the mountains, they were trapped by snowfall after snowfall. They had to spend the winter high in the mountains near Lake City, east of Silverton.

In spring, the only person to emerge unscathed was Packer. Naturally, everyone's curiosity was aroused, and he finally admitted that the argonauts he had guided had killed each other and eaten human flesh. A search team went into the mountains and found the remains of the entire gold party that Packer had guided. Most had been murdered, and chunks of flesh had been hacked from each of the bodies. This led investigators to the conclusion that Packer, who appeared hale and hearty after his winter ordeal, had feasted on human flesh. He was tried and convicted and served his time, ending his life in quiet solitude once released from prison.

The last big find of Colorado gold was found in the 1890s, though an old-timer named Bob Womack had been touting the locality just west of Pikes Peak for years. No one believed old Bob when he told folks there was gold in the Cripple Creek area. (The creek had gotten its name when a steer had fallen in it and broken a leg.) Cripple Creek gold had two problems that deterred recognition. One was an earlier gold rush to Mount Pisgah, west of Cripple Creek, which had proved to be a scam. That turned folks against any notion that gold existed west of Pikes Peak.

The other problem was the gold itself. It did not occur as a bright-yellow metal in quartz or other rock. Instead, the gold was locked in two chemical compounds, the minerals calaverite and sylvanite. They simply did not look like gold, but they were rich in the yellow metal. All you had to do was heat these minerals to break them down and release the gold from the composition, and the gold would emerge as bright-yellow blisters on the rock.

When folks finally did realize Womack was right and gold was there for the mining, a rush commenced. Cripple Creek became the last gold rush boomtown within what was then the United States.

For collectors, the species to collect from the Cripple Creek mines are those same gold tellurides: sylvanite, a gold, silver telluride, and calaverite, a gold telluride.

It was the initial discovery of gold on Cherry Creek in 1849, remembered by the returning argonauts, that soon triggered prospecting and, ultimately, discovery of gold and silver in the nearby mountains. Continued strong migration resulted in more discoveries of silver and gold at places like Leadville. This exploration west of Denver is what really opened the Rocky Mountains and the territories west of there to mining and, eventually, development. You know the rest. Superb minerals are still being mined and dug in Colorado, one of America's richest mineral provinces.

Shop Talk

by William A. Kappele

Stabilization

Not long ago, I heard from a reader who was looking for information on stabilizing stones. For those of you who are just getting started in the hobby, stabilization is a way of treating soft or fractured stones so that they can be worked by the lapidary. Although almost any soft stone can be stabilized, turquoise comes immediately to mind when the term is brought up. The vast majority of stabilized stones are produced commercially, not in a home shop, and as we would expect, these processes are either "undisclosed" (secret) or far too complicated and dependent on equipment not readily available in our basements, garages, or backyard shops.

What our reader and most of the rest of us want to know is how to perform this modest miracle in our home shop. Well, it can be done, but, as you might expect, the results will probably not be quite as spectacular as those from the commercial methods. I'll go through some of the common home methods, and you can pick one to try or try them all if you are in the mood. Remember that you can try this with any porous or fractured stone. You aren't limited to turquoise.

Let me add a personal note before I describe the processes: Cut your stone close to the finished dimensions before you use the stabilizing solution. Without using heat and pressure, it will be difficult to get the solution to penetrate the stone very deeply.

The first and a very old method is to soak the stone in sodium silicate (more commonly known as waterglass) and let it dry. You should be able to find waterglass in a local drugstore or hardware store, but if you have trouble, you can get it on the Internet at www.secure.sciencecompany.com/thesciencecompany/product1.cfm?&product_id=592.

Lots of folks have tried this method, and each has his own pet way of doing it. The general idea is to mix the waterglass 50/50 with water and place it in a glass jar or bowl. Soak your stones in the solution for about a week to 10 days, depending on their size. Remove the material from the solution and let it air dry for another week.

At that point, it should be ready to work, but some people recommend heat treating. Take a baking pan, put a layer of sand on the bottom, set the stones on the sand, cover them with another layer of sand, and bake them in an oven for an hour or two. You will have to do a little experimenting to see what works for you.

A more modern, but similar, method utilizes epoxy for the stabilizing agent. You will need a water-clear material like Epoxy 330 and some acetone. All the formulas I have seen say to squeeze the contents of both the epoxy and the hardener tubes into a pint of acetone in a glass jar and mix them well. Then add your stones and let them soak for about a week. It seems to be a good idea to stir or swirl the mixture every day, probably to keep it from separating. Remove the stones from the mixture and let them air cure for another week. (This cure time could probably be speeded up with a heat gun.) Be careful with heat or sparks. Acetone isn't tap water.

A third, similar method is to use an old favorite for filling cracks in opal, Opticon. This is another epoxy, but it is used slightly differently from the last example. Heat is used to help the resin penetrate, and the hardener is not applied until the soak is finished. Just follow the instructions on the can, and you should get the results you want. For a fine description of one man's use of Opticon on opals, visit the Web site www.villagesmithyopals.com/opalcut.cfm.

Well, there are some stabilization methods to try. With some patience and experimentation, you should be able to salvage some of those nice chunks of leaverite that you have collected over the years.

Have fun!

Please feel free to contact me if you have a suggestion or comment about this or any of my Shop Talk columns. My e-mail is quappelle@cox.net, or write to me at 25231 Pericia Dr., Mission Viejo, CA 92691.

CYANIDE: The Real Story

A Look at the Chemical That Revolutionized Gold Mining

Story and Photos by Steve Voynick

The final step in the cyanidation gold-recovery process is melting the precipitated gold and pouring it into ingots.

Numbers, whether referring to troy ounces, tonnes (metric tons), or dollars, are among the most fascinating aspects of gold and gold mining. As an example, consider the numbers that define current annual world gold production: 90 million troy ounces, or about 2,900 tonnes, worth more than $40 billion.

Now consider a less-familiar gold-mining number: About 95 percent of the world's newly mined gold is currently recovered through the use of cyanide.

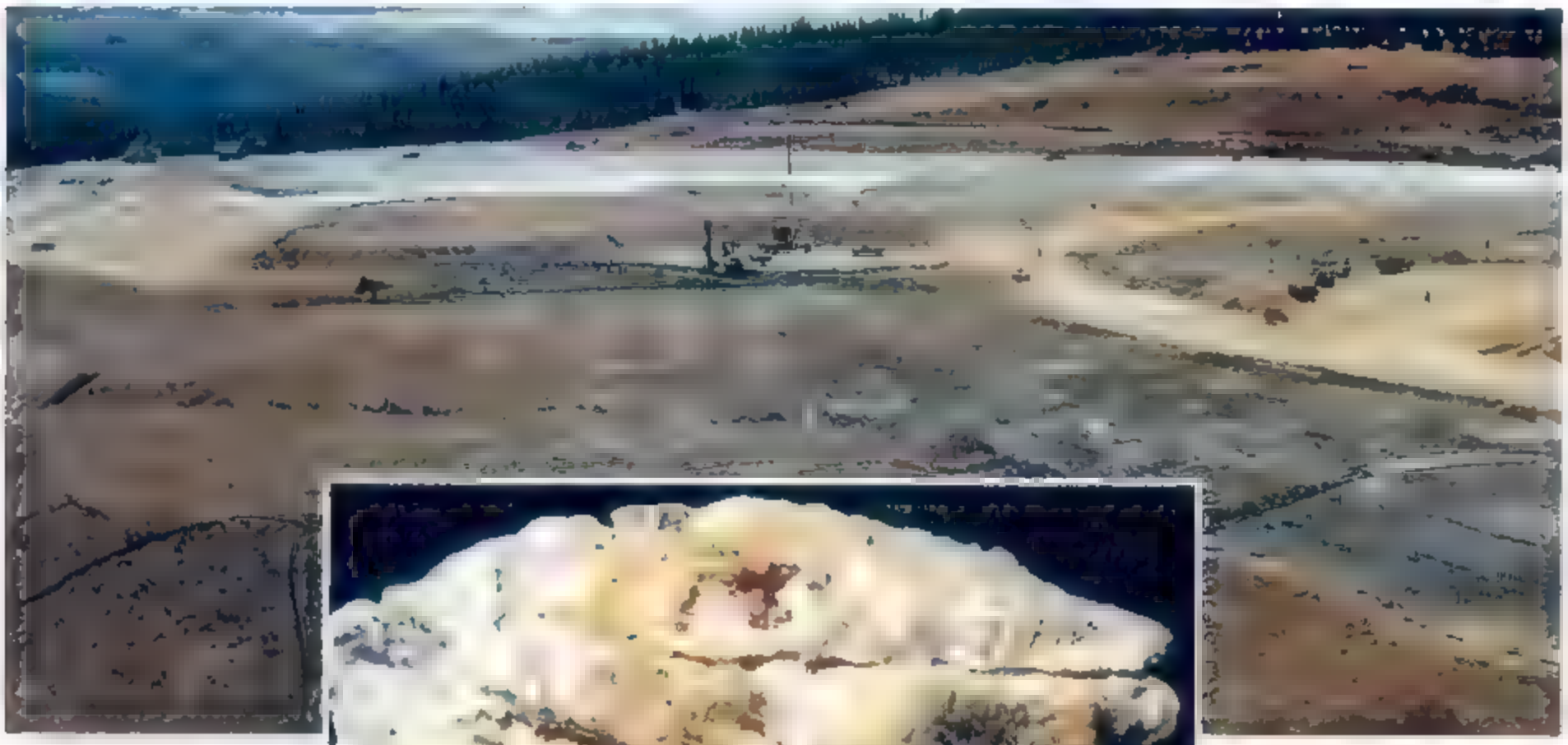
The word "cyanide" always raises a few eyebrows, and for good reason. To the general public, cyanide is synonymous with poison. After all, villains have made cyanide their poison of choice in countless novels. It is also employed in real-life execution gas chambers. And it will always be associated with such human tragedies as World War II genocide and the Jonestown, Guyana, mass suicides.

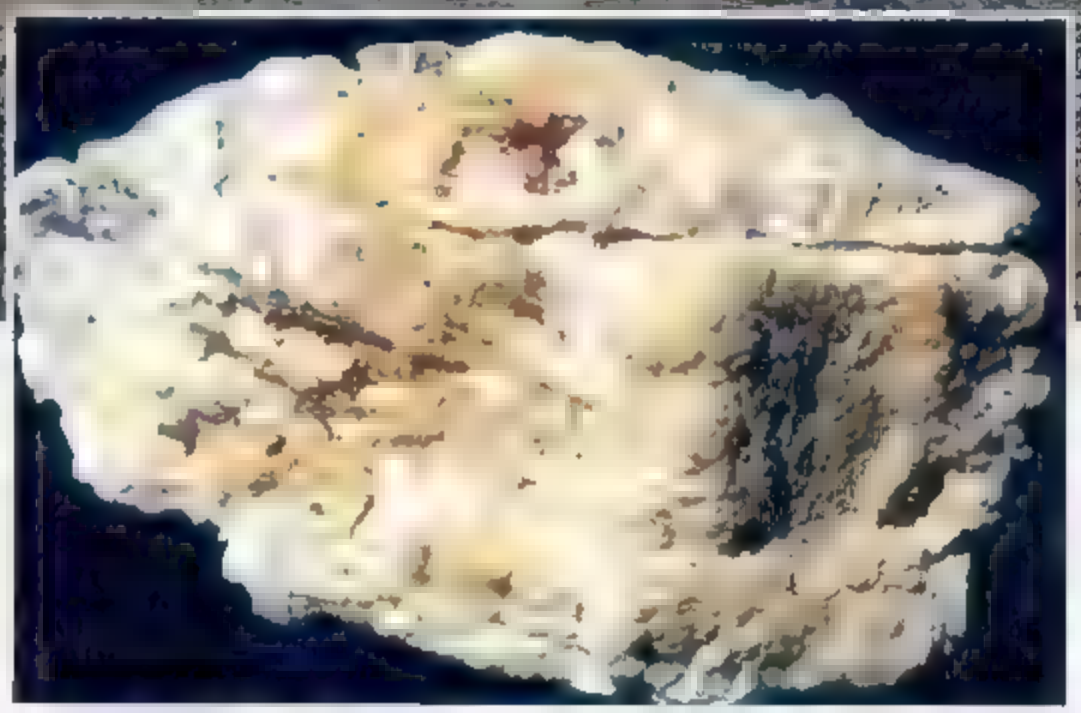
Cyanide is indeed toxic: just 1/2 gram can kill an adult. With that kind of toxicity, one might expect cyanide to be manufactured sparingly, stored in tiny vials, and locked safely away in laboratories.

Instead, the gold-mining industry alone uses 700 tonnes of cyanide *every day*. That adds up to a quarter-million tonnes each year. To express this usage on a personal level, imagine a gold pendant containing 1 troy ounce of gold. To recover that single ounce of gold, miners used 4 *pounds* of cyanide.

"Cyanide" is a general term that refers to a host of chemical compounds containing the cyanide radical $(CN)^-$, a composite ion consisting of carbon and nitrogen. The specific cyanide compound favored by gold miners is a white, granular powder called sodium cyanide (NaCN). It is extremely toxic when ingested and can cause serious damage when released into the environment.

Sprinkler systems spray sodium-cyanide solution onto crushed gold ore in a heap-leach pad. It will percolate through the ore and collect the gold.





Before the introduction of the cyanidation process, only high-grade gold could be cost-effectively mined.

Yet, despite its dark reputation, sodium cyanide has altered the course of gold-mining history and revolutionized the gold-mining industry. It continues to sustain the current multibillion-dollar levels of world gold production. Other cyanide compounds are used to manufacture everything from dyes and pharmaceuticals to plastics, nylon, and gold-silver electroplating solutions. Nevertheless, the cyanides remain among the most maligned, feared and misunderstood of all industrial chemicals.

Cyanide first came to light during the dawn of scientific chemistry in the early 1700s when two German researchers heated dried animal blood together with potash (potassium carbonate obtained from wood ash) and green vitriol (iron sulfate). The result was an intensely colored blue compound of uncertain composition that was named "Prussian blue" and was valuable as a dye.

In 1782, Swedish chemist Karl Wilhelm Scheele heated Prussian blue with dilute sulfuric acid to generate a gas that dissolved in water and formed an acid. Scheele named this acid prussic acid, taking its name from Prussian blue.

Then, in 1811, French chemist Guy Lussac determined that Scheele's gas was hydrogen cyanide (HCN). He also found that prussic acid was an aqueous solution of hydrogen cyanide (called hydrocyanic acid), and that Prussian blue was hydrated ferric ferrocyanide. (The name "cyanide" derives from the Greek word kyanos, meaning "blue," a reference to Prussian blue, the first recognized cyanide compound.) During his studies, Lussac also used hydrocyanic acid to produce other cyanide compounds, including sodium cyanide and potassium cyanide.

Approximately 1½ tons of sodium cyanide are needed to extract the gold in a 72-pound ingot.

By 1830, chemists already realized that aqueous cyanide solutions had the unusual ability to dissolve gold and silver. While some applied this knowledge to preparing gold electroplating solutions, others wondered if cyanide could extract gold from ores. While they found that cyanide could indeed extract some gold from ores, the rate of gold solubility was too low for commercial application.

Nevertheless, scientists remained very interested in the interaction of cyanide and gold. In 1846, German chemist Fritz Elsner defined the reaction that occurred when gold dissolved in a sodium-cyanide solution as $4Au + 8NaCN + O_2 \rightarrow 4NaAu(CN)_2 + 4NaOH + 2H_2O$, an equation known today as "Elsner's formula." Elsner also described the combined form of dissolved gold as an "aurocyanide complex," a term still in use today. Then, in 1857, British physicist Michael Faraday discovered that oxygenating cyanide solutions by simple aeration greatly increased their ability to dissolve gold.

In Faraday's time, gold miners relied on three basic, time-tested recovery processes: gravitational separation, smelting, and amalgamation. All were relatively costly, very inefficient, and suited only for high-grade ores. And as ore grades inevitably declined in the 1800s, researchers began seeking a better gold-extraction technology.

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Cyanide: The Real Story *from page 21*

The first new technology was introduced in the 1870s. It was chlorination, a process that mixed chloride compounds like common salt with reducing agents and crushed gold ores. When heated, this mixture generated chlorine gas, a powerful oxidizing agent that converted metallic gold to soluble gold chloride. Continued heat then vaporized the gold chloride, which was collected in retorts as a solid condensate or leached with water and collected as a solution.

Although chlorination improved recovery efficiency somewhat, its big drawback was the chlorine itself. This deadly gas rapidly corroded every metal it touched and made tending the furnaces extremely hazardous for mill workers.

In 1887, while gold miners either continued using the traditional separation methods or took their chances with chlorination, John Stewart MacArthur, a chemist in Glasgow, Scotland, was working on the gold separation problem with his two backers, brothers and medical doctors Robert and William Forrest. MacArthur focused on cyanide solutions, but with a new approach. Rather than using concentrated solutions in the hope of increasing gold solubility, MacArthur worked with very dilute solutions. He found that well-aerated solutions containing only a tiny fraction of a percent of potassium cyanide increased the solubility of gold (and silver) enough to have commercial potential.

MacArthur then added powdered zinc to his gold-bearing cyanide solutions. The chemically active zinc displaced the gold within the dissolved aurocyanide complex, allowing the gold to precipitate out of solution for recovery as a gray yellow metallic powder.

After refining his methods to maximize gold solubility and recovery, MacArthur patented his process in London in 1888 under the title "A Process for Obtaining Gold and Silver from Ores." The following year, MacArthur took his process, known as the MacArthur-Forrest Process, to South Africa, which turned out to be exactly the right place at the right time.

Prospectors had found gold, lots of it, in the Witwatersrand in 1886, when South African diamond mining was already booming. Because diamond magnates had eagerly provided both mining expertise and capital, gold-mining development had proceeded rapidly. The first gold mines, shallow and working rich ores, profited handsomely. But ore grades quickly declined as the gold-bearing reefs went deeper underground. With no efficient way to process lower-grade ores, mines closed, stock values plummeted, and the future of South African gold mining was left dying on the vine.

That was when MacArthur established the African Gold Recovery Co. and set up a pilot cyanidation plant to treat the low grade ores. By May 1890, his plant was performing flawlessly and miners were lining up to buy licenses to use his cyanidation process. Almost overnight, cyanidation revived South Africa's gold-mining industry beyond anyone's wildest hopes. Within a decade, South African gold production would skyrocket, with virtually every ounce extracted with the MacArthur-Forrest cyanidation process.

MacArthur then took his process to Australia, New Zealand, the United States, and other major gold producing regions, issuing dozens of cyanidation licenses in return for royalties that amounted to $1.36 on every troy ounce of recovered gold. Considering that gold was then worth only $21.67 per troy ounce, the royalty rate was substantial. But if miners wanted to work lower grade ores, they had no choice but to use to cyanidation.

Mining companies grumbled, but paid MacArthur's hefty royalties for several years. Then, in 1894, the Chamber of Mines, the South African colonial government's mine bureau, asked MacArthur to reduce what it viewed as an excessive royalty rate. When MacArthur adamantly refused to lower his rate, the Chamber of Mines filed suit in London's High Court, charging that his original patent was invalid because the patentees were not the true inventors of the cyanidation process, and claiming that the process was properly part of the pubic domain. The hearings lasted six months and drew testimony from more than 100 mining and chemical experts from around the world.

Finally, in 1896, the judges voted 2 to 1 in favor of the plaintiff, handing down a 70-page decision, which read in part, "... there is nothing novel in the diluting of a well-known solvent or reagent for the purpose of winning gold from quartz." By voiding the patent, the court released the MacArthur-Forrest cyanidation process to anyone's use free of charge. Had MacArthur been willing to drop his royalty rate, he and his heirs would have become fabulously wealthy. Instead, he was burdened with more than $1 million in legal fees and died in poverty 24 years later.

Meanwhile, others had improved the MacArthur-Forrest process. It initially specified the use of potassium cyanide, but most mines quickly switched to sodium cyanide for its slightly higher gold-solubility rate. Instead of using powdered zinc to precipitate the gold in the final step, in 1894, independent researchers had patented the carbon-adsorption process, which used carbon's strong affinity for gold to adsorb the metal out of solution. That eliminated the need for costly zinc, but the gold-laden carbon had to be smelted to burn off the carbon and recover the gold.

Inside a carbon-in-pulp (CIP) recovery facility, pregnant cyanide solutions from the leach pads are mixed with activated charcoal (carbon) in large vats

Science learned much more about cyanide during the 20th century. Cyanides are naturally occurring compounds produced by many plants, animals, fungi, and bacteria. Traces of cyanides are present in such foods as cashews, potatoes, cherries, soybeans, and, most notably, in almonds and apricots. Cigarette smoke also contains high levels of cyanides, but cyanides are not carcinogenic, and the liver easily removes normal trace amounts.

Chemists also learned the reason for cyanide's notorious toxicity. Cyanide binds to key iron-containing enzymes, destroying the ability of living cells to use oxygen and of the blood's hemoglobin to transport oxygen.

Cyanide is not particularly stable and degrades rapidly through many natural physical, chemical, and biological processes. Cyanides oxidize in air and break down under the ultraviolet component of sunlight into nontoxic or much less toxic compounds. Unlike such heavy-metal pollutants as lead and mercury, cyanides, despite their initial toxicity, do not accumulate in organisms or in the environment.

Following World War II, cyanides found many new uses in pharmaceutical manufacturing, as steel-hardening addi-

tives, and as a feedstock for the manufacture of nylon and other synthetic fabrics. To satisfy growing industrial demand, chemists devised better ways to mass-produce cyanides by treating caustic soda (sodium hydroxide) with hydrocyanic acid, or by passing electric current through a mix of natural gas, caustic soda, and ammonia. As production increased sharply, cyanides became more affordable than ever.

In the 1950s, cyanidation was further improved when U.S. Bureau of Mines researchers devised the carbon-in-pulp (CIP) process, which eliminated the need to smelt the gold-bearing carbon in the final recovery step. In CIP, gold-bearing leach solutions were mixed with granules of activated charcoal. The gold-laden charcoal was then floated off and piped into heat-pressure vats where hot, aqueous ammonia solutions redissolved the gold. A final step precipitated the gold out of solution for recovery.

Until this time, cyanidation had been employed only in batch-type processes, in which finely crushed gold ore was immersed in dilute sodium-cyanide solutions in large steel vats. Several hours later the gold-bearing, or "pregnant," cyanide solution was drained, the expended ore removed, and new ore dumped into the vat, and the entire process repeated. The pregnant cyanide solution was then piped to CIP facilities for gold recovery.

The 1961 opening of the Carlin gold mine near Elko, Nevada, introduced an entirely new approach to cyanidation. At the Carlin, huge quantities of extremely low-grade ore (grading less than 0.1 troy ounce per ton) was mass-mined from open pits. The ore was crudely crushed to 2-inch size, then dumped into a large surface depression called a leach pad. A dilute, basic solution of sodium cyanide released through sprinklers trickled down through the massive ore heap. The pregnant cyanide solution was collected from the bottom of the pad and pumped to a CIP-recovery facility. When the Carlin Mine began producing gold at a solid profit, the gold-mining industry had a clear vision of its future.

With the technology in place to efficiently extract gold from very low-grade ores, sufficient economic incentive remained the only barrier to a major gold-mining boom. That emerged during the 1970s, when gold's new status as a free-market commodity sent its price skyrocketing. Dozens of big, new gold mines, many in Nevada, went into development, every one utilizing cyanide heap-leach extraction.

continued on next page

Cyanide *from page 21*

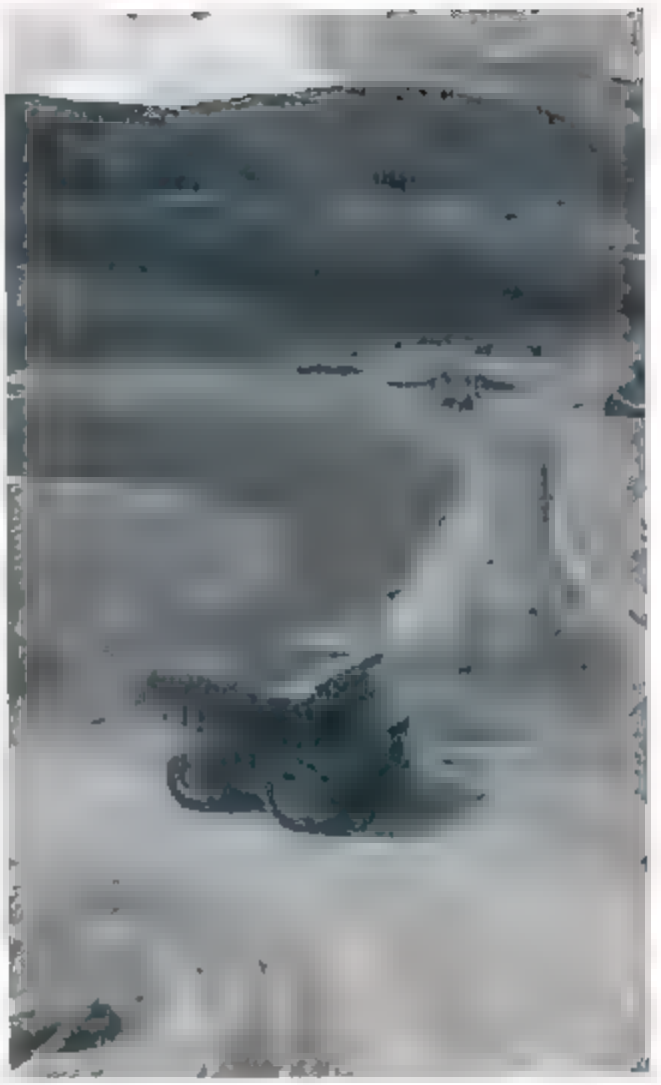
Despite its general effectiveness, cyanide is not the ideal chemical for gold extraction. For maximum recovery efficiency, gold must occur in discrete, clean particles in ore that is free of cyanidation inhibiting minerals. These include sulfides, which oxidize during leaching, thus depleting available oxygen and reducing leaching efficiency. Another is carbonaceous ore, in which elemental carbon immediately adsorbs gold back out of the pregnant cyanide solution. Such ores require roasting or chemical pretreatment before cyanidation.

Nevertheless, the reserves of shallow, oxidized gold ore suitable for direct cyanidation were enormous. Thanks to cyanide, annual U.S. gold production soared from just 1 million troy ounces in 1980 to 10 million troy ounces by the early 1990s, a level that has since been sustained. Meanwhile, cyanide heap leaching steadily boosted annual world gold production to its current level of 90 million troy ounces.

Today, sodium cyanide is used to extract 95 percent of the world's newly mined gold. The other 5 percent comes from byproduct recovery at silver and base-metal smelters, and from small mines that still rely on gravitational separation or, in some third world countries, amalgamation.

Extracting all this gold takes huge amounts of sodium cyanide. Even though leaching solutions are very dilute (as low as 0.01 percent sodium cyanide), they are used in great volume. Dissolving only a single troy ounce of gold requires 10,000 gallons of sodium-cyanide solution, and because cyanide is slowly broken down by sunlight and air, leaching solutions must be continually replenished. The chemical industry now produces some 1,125,000 tonnes of sodium cyanide each year, 80 percent of which 160,000 tonnes is shipped to gold mines.

To the credit of the gold-mining industry, there has never been a documented human fatality in more than 125 years of cyanide use, but there have been environmental calamities. Over the last 30 years, cyanide has been involved in nine of the world's 23 significant mining-related environmental incidents. Among the worst was a breached tailings impoundment at a large Romanian mine in 2000. The cyanide that entered the Tisza and Danube rivers killed large numbers of fish, disrupted the drinking-water supply for millions of people, and could be detected 1,200 miles downstream. A similar accident in 1995 in Guyana dumped large amounts of cyanide laced water into the Essequibo River, where it devastated aquatic life.



A modern heap-leach pad is lined with tough geotextile fabrics and impermeable layers of clay to contain the cyanide solutions.

The United States, despite strict mining regulations, has also had its share of cyanide spills, notably in South Carolina and Colorado. Cyanide spills, however, should not be confused with the larger problem of mine-drainage pollution, in which heavy metals and acid cause environmental degradation.

The mining industry has long sought and continues to seek alternatives to cyanide for extracting gold from ores. Researchers have extensively tested many chemicals, among them thiourea, thiosulfates, and certain halogenous compounds, but so far nothing has approached the extraction efficiency and cost effectiveness of sodium cyanide.

And just how much does sodium cyanide cost? High-volume manufacturing has dropped the price of a tonne of industrial-grade sodium cyanide suitable for leaching gold ore to $1,600, or about 70 cents per pound. Thus, 4 pounds of sodium cyanide costing about $2.80 is the key to recovering 1 troy ounce of gold, currently worth $450.

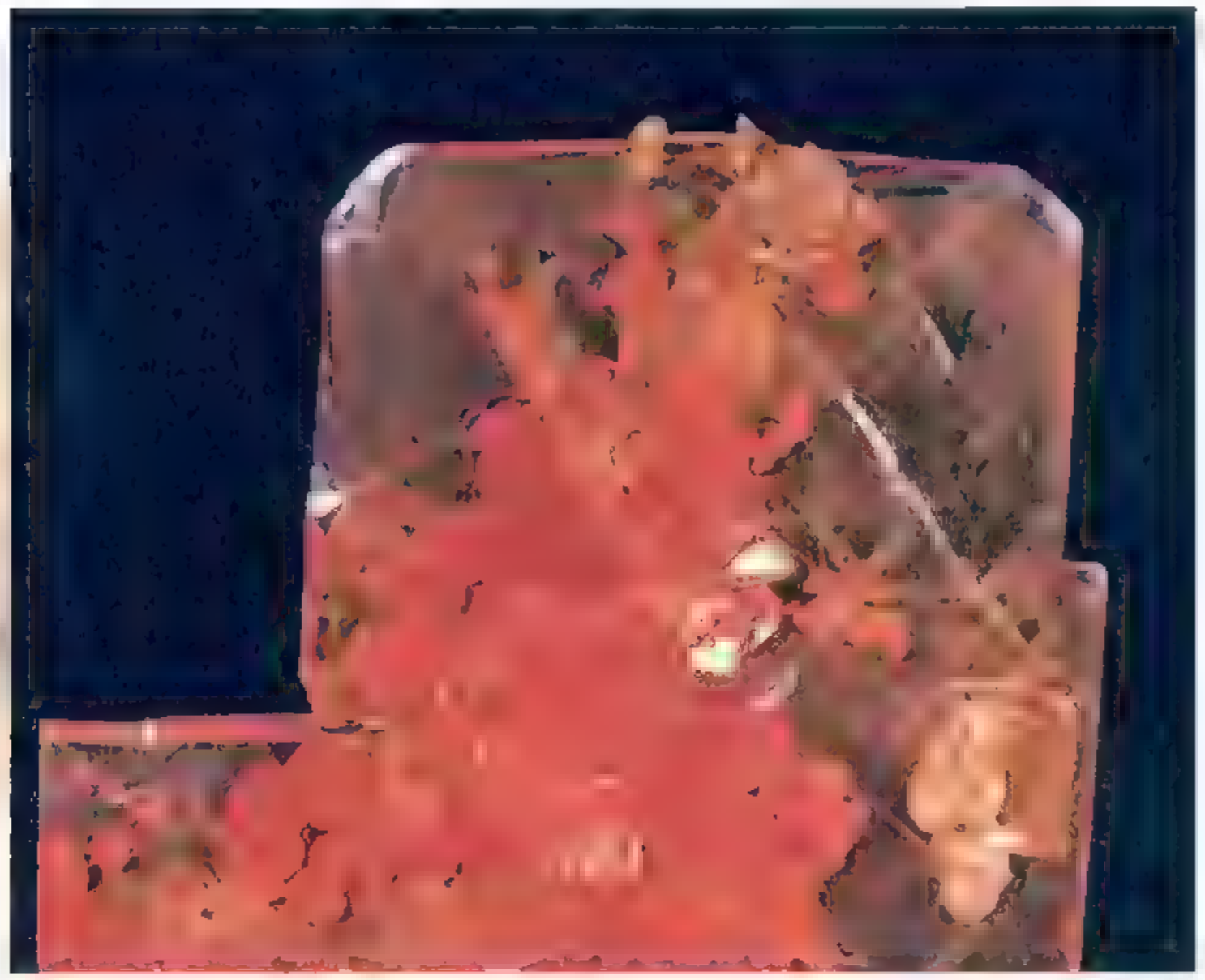
While the gold-mining industry will continue to rely on sodium cyanide, at least for the foreseeable future, its use will likely remain controversial. And while we can debate whether cyanide should or should not be used to extract gold from ores for environmental or safety reasons, no one can question its enormous impacts on the history of gold mining and on world gold production.

THE FRUGAL COLLECTOR

MIMETITE

It Imitates Pyromorphite

Story and Photos by Bob Jones



Sometimes, the brightly colored mimetite from the San Francisco Mine formed right inside the wulfenite blades.

The San Francisco Mine, in Cucurpe, Mexico, has produced some of the world's finest mimetite-wulfenite specimens

For decades, perhaps several hundred years, mimetite didn't even exist as a distinct mineral in the minds of mineralogists and miners. They thought it was something else. Operators of German silver and lead mines, where it probably first occurred in quantity, simply assumed it was just another form of the lead mineral pyromorphite, which it so closely resembles. After all, it is hexagonal, occurs in a range of colors not unlike pyromorphite, and, most important, it also produces lead when smelted. The obvious, though erroneous, conclusion was that this mineral, which occurred just about everywhere pyromorphite was found, was just another form of that lead chloro-phosphate.

The confusion came about because these two minerals form the end members of a complete series. This means each can be found in a pure state, but it is very unlikely. Much more commonly, pyromorphite and mimetite have a trace of each other within their chemical structures.

Both are secondary lead minerals. Pyromorphite contains the phosphate radical (PO_4), while mimetite contains the arsenate radical (AsO_4). In all other respects, they are alike, so you can't eyeball a specimen and tell with certainty what it contains. Furthermore, the lead chloro-phosphate pyromorphite will likely contain a little of the arsenate radical, and mimetite usually sports some of the phosphate radical. Because of this we have even given a special name, campylite, to a

compound of lead with both the arsenate and phosphate radicals in its chemical structure

One of the interesting features you may see in pyromorphite and esepecially in mimetite is internal concentric zoning, which is revealed best when a crystal is broken It may even be seen at the crystal termination This alternating light-dark zoning is due to alternating structures of the phosphate radical and the arsenate radical in the crystal's structure

The identity of any mineral with two different controlling radicals is determined by the radical that is most dominant. Campylite normally contains more of the arsenate radical than the phosphate radical, so it is considered a form of mimetite Lately however, scientists have decided the term "campylite" is less accurate and the mineral, since it contains a significant amount of phosphate radical, should be called "phosphatian arsenate" I prefer the older moniker

This interesting form of mimetite has been found in several places, but the one important source for campylite is Dry Gill and Roughton Gill, in Caldbeck Fells, Cumbria, England Villevielle France, was another source, but it never produced anything like the quantity from England. Distinguishing features of campylite crystals are their curved prism faces, which give them a barrel shape, and their color, which ranges from brown to yellow-brown to brown-orange. Be careful, though, some pyromorphites take on the same barrel shape and can exhibit the same colors. Again, only your chemist knows for sure

The Caldbeck Fells region of England also yielded pyromorphite As expected, it has some of the arsenate radical, which affects its color and form; therefore, the mineral should be called arsenian pyromorphite Much of the lead chloro-phosphate found in other deposits is actualy arsenian pyromorphite.

As if the mimetite-pyromorphite confusion is not enough, the vanadate radical (VO_4) also gets into the chemical mix. It is not uncommon for the vanadate radical to substitute for the arsenate radical, forming yet another part of the series When the arsenate radical and vanadate radical are found in the same mineral, they form the mineral endlichite, an arsenian vanadate.

Therefore, these three species form a three-member series, the arsenate-pyromorphite-vanadate group. You can show this series very simply by positioning one of these three minerals at each corner of a triangle Along the lines connecting any two of these minerals can be a variety, like campylite,

EVAN JONES COLLECTION

This superb example of botryoidal yellow mimetite is from the Congresso-Leon Mine in Chihuahua, Mexico.

endlichite, arsenian pyromorphite, etc No wonder there is confusion when deciding between pyromorphite and mimetite! Oddly, there seems to be no important and distinct mineral variety recognized between vanadinite and pyromorphite

Mimetite is not as abundant as pyromorphite, which is the most popular member of the series because of its color, attractiveness and abundance. Still, mimetite can be green yellow, brown, tan, orange-yellow, orange brown, and brown-red. Certainly, mimetite has been found in collector-quality specimens far more often than vanadinite, the third member of the series. On the other hand, vanadinite, with its fiery red color and large hexagonal crystals, can be showier than mimetite.

As I said, mimetite has long been easily confused with pyromorphite, so it was named after the Greek word "mimetes," meaning "imitator." It forms in the hexagonal crystal system, the same as pyromorphite and vanadinite. Crystals can be stout hexagons with a flat termination or a pyramidal termination. They are also found as long, tapering, pointed, acicular crystals. When massive, mimetite is either globular or mammillary. One of its most common forms, especially in Arizona, is as a velvety coating of micro crystals on matrix, almost always with beautiful wulfenite crystals on it Its most attractive color in this form is a rich orange-red.

Normally, mimetite does not fluoresce, but specimens from Tsumeb sometimes show a weak orange color under long-wave ultraviolet, while mimetites from Australia's Broken Hill can show an orange color under short-wave radiation

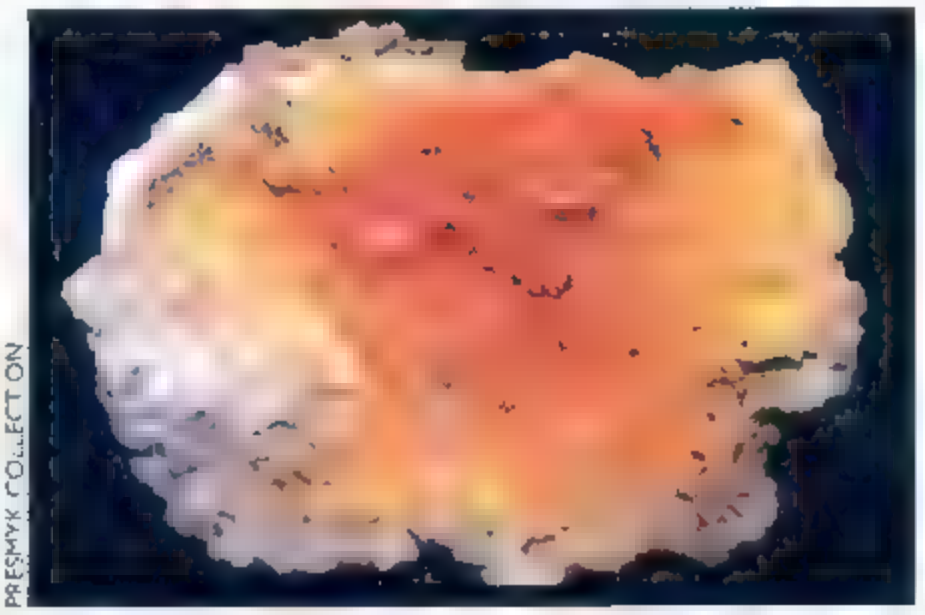
Mimetite, as common as it was in some of the early mines worked in Germany for silver ore, was not identified as a distinct mineral species until 1832

Even today, there is some confusion over identifying a particular mineral as pyromorphite or mimetite, most often when specimens are in the tan to brown or even the orange color range. It all depends on the arsenate content It's well established that the arsenate radical in this series often causes pyromorphite to take on a tan to brown to orange color instead of bright green Still, you cannot use color as a guide, so only your chemist knows for sure whether the arsenate or phosphate radical dominates and determines the mineral in hand.

In 1982, the Bunker Hill and other mines near Kellogg, in the Coeur d'Alene district of Shoshone County, Idaho, produced spectacular, bright, lime-green pyromorphite hexagons in subparallel, intergrown masses of crystals, most without matrix Some specimens were a foot across When these superb pyromorphites appeared, they caused an instant sensation

Further mining revealed additional masses of highly lustrous botryoidal brown or orange-brown and even orange material Initially, they were thought to be pyromorphites, as they were found right in with the green lead phosphate specimens, but because of the rich brown-orange to brown color and botryoidal habit many thought these specimens were mimetite. Eventual testing proved they were arsenian pyromorphite! There simply was not enough of the arsenate radical in the structure of these lovely specimens to tip the balance in favor of mimetite

Some of the first really good mimetites found in this country came from Phoenixville, in Chester County, Pennsylvania Better known for fine green pyromorphite, this locality produced some really nice tan mimetites, some as small crystals, others in globular form



PRESMYK COLLECTION

This colorful mimetite on barite is a good example of the material from the Rowley Mine in Maricopa County, Arizona.

continued on next page

The aforementioned German mines are famous for their green and tan pyromorphite crystals. The mines at Johannesgeorgenstadt, Saxony, produced superb pyromorphites, but the mines that produced Germany's finest specimens were at Bad Ems. The mineral occurred there in huge quantities in two different forms. Most popular where choice, large, green crystals, the finest were arranged like an open mouth with ½-inch to 1-inch green, hoppered crystals jutting up from the matrix and hanging down into the opening. The finest of these, from the Carl Bosch collection, were displayed at Tucson by the Smithsonian Institution.

The other pyromorphite commonly seen in the Bad Ems lead mines are tan crystals. These occur in subparallel clusters of hoppered crystals, some of which are nearly an inch long. Luster ranges from almost greasy to dull. The color ranges from dark brown to light tan, with many crystals showing a gradual color change from darker brown at the crystal base to light tan at the hoppered terminations. Some of the clusters of tan crystals were 6 and 7 inches long, solid masses of crystals without matrix in fist-size groups. There was never any question that these tan crystals could be mimetite, since mimetite was not known when they were originally mined. I've never heard of them referred to as arsenian pyromorphite either. Later, mimetite was recognized within some of the pyromorphite occurrences in Germany, but was never as common as the pyromorphites.

The finest crystallized mimetites have undoubtedly come from the Tsumeb mine at Tsumeb, Namibia. This remarkable lead, copper, cobalt, germanium deposit has produced several hundred species, including superb mimetites. The most attractive Tsumeb mimetites are bright-yellow, gemmy prisms to nearly 2 inches. Found in small, diverging clusters, these mimetites really excited the mineral world, even though the number of specimens was rather limited.

A second type of mimetite found at Tsumeb is equally attractive. The crystals are slender acicular prisms that range in color from a good pink to nearly colorless. Found in clusters on masses of galena, these mimetites were more common than the more attractive, gemmy yellow prisms. Since both types of mimetite from Tsumeb are in limited supply, collectors are hard pressed to find a good specimen, so other sources have to suffice.

Though mimetite is not as common as pyromorphite, the mimetites from Mexico have created their own excitement because of their superb color, large quantity, and, in one case, their wonderfully colorful association with wulfenite.

The mimetite from the Congresso-Leon Mine in San Pedro Corralitos, Chihuahua, is a rich canary to dark-yellow color in lovely botryoidal form. A huge deposit of this very attractive massive mimetite was discovered in 1984.

One type of mimetite found at Tsumeb, Namibia, is abundant clusters of slightly pink needle crystals.

Benny Fenn, a well-known mineral dealer, was prospecting in the mine when he discovered a large zone of granular cerussite. The deposit was large enough to warrant mining it for lead ore. Little did Fenn know that, when mining commenced—an effort that extracted tons of the lead carbonate cerussite—he would encounter veins of brilliant yellow botryoidal mimetite.

The first load of this lovely mineral that he brought to the United States ranged from pale yellow to good yellow. It was very nice, but not spectacular. These specimens consisted of rounded masses of mimetite in botryoidal form; they were poorly attached to each other so they easily parted into small, rounded specimens. Larger specimens of this early find were somewhat friable because the grapelike sections broke apart so easily. In spite of that, the mimetite was easy to sell because of the color and relative scarcity.

Today, specimens, even when found in quantity, sell individually. Thirty years ago, when wholesalers were an important part of the hobby, quantities of minerals often sold by the pound. For example, you could buy choice adamite from Mapimi for as little as $2 per pound, and I didn't Fenn's initial find of mimetite at San Pedro Corralitos was sold wholesale for $3.75 a pound. San Pedro Corralitos is the locality name usually given for these mimetites, but the actual mine name seldom appears on labels. It is the Congresso-Leon Mine.

As mining of the cerussite continued, the walls behind that deposit were revealed to have a series of open veins holding more and more fine yellow mimetite, far better than the initial find. Gradually, the quality of this lead arsenate improved. The color became a more lustrous bright canary yellow and the specimens were much sturdier, holding together in solid, undulating masses. This is the exceptionally colorful and firm mimetite collectors today think of when the mimetite from San Pedro Corralitos is mentioned. Since the quality of this later find was far better than the initial lot, it sold wholesale for a lot more money—$5.75 a pound!

A couple of years after this find, Benny Fenn guided me, my son Evan, and several others into the Congresso Leon Mine so we could see for ourselves where the mimetite was found. We had hopes of opening another productive seam, but we failed to do so. Still, it was an interesting experience. We did get a lot of calcite specimens, but they hardly compared with the hoped-for mimetite.

There is no question in my mind that the San Pedro Corralitos specimens are among the best ever found. Today, they command prices up to four figures! Still, this lovely mimetite does not exceed the bright-red mimetite found associated with choice wulfenite at the San Francisco Mine in Mexico in the mid-1970s. The difference, aside from color and form, is that the mimetite from San Pedro Corralitos is just individual specimens of mimetite with no associated minerals. The San Francisco Mine mimetite, as brilliantly colorful as it is, only occurs in a supportive role, almost never as an isolated species in spectacular groups.

The San Francisco wulfenite/mimetite combination was mined from an old gold mine at the abandoned village of Cucurpe, east of Hermosillo, Sonora, Mexico. Now famous because of this combination of lead minerals,

the San Francisco Mine has produced what I consider the finest wulfenite/mimetite combination ever found anywhere in the world. Because of their brilliant color combination, the San Francisco Mine wulfenite-mimetite specimens have a greater eye appeal than the more famous wulfenites from the Red Cloud Mine in Arizona.

Specimen mining began in the San Francisco Mine in the mid 1970s and quickly produced nice, transparent, thin bladed, yellow wulfenite to an inch or more on an edge. These were considered very nice, but with dozens of mines in Mexico and the American Southwest producing wulfenite, these early Cacurpe wulfenites were not distinctive.

This wulfenite was only a glimmer of what was to come: amazing, brilliant orange-red, transparent wulfenite blades, many exceeding an inch on an edge. These are spectacular enough, but most are heavily decorated with even brighter red spherules of mimetite. The mimetites are seen in between clusters of wulfenite. They also perch on the crystal edges of the wulfenite and, in some cases, are embedded and even penetrate right through the thin wulfenite blades. The two minerals clearly formed at the same time, and are intergrown or attached to each other. Their color is undoubtedly due to a trace of chromium, though I am unaware of any tests to prove that.

The better wulfenites range in color from rich yellow to a good orange-red to nearly red. The crystals are typical tetragonal blades, nearly square with minor modifications along the edges. Most are paper thin and range from under an inch to as much as 5 inches on an edge. The largest single crystal found during this mining operation was 5 inches on an edge, a single flat blade with minor mimetite. Unfortunately, when someone was admiring the crystal by holding it flat in the palm of the hand, their body heat shattered the blade! Wulfenite is paper thin, so you handle it infrequently or not at all.

Tight clusters of the wulfenite blades are typical of the better specimens from Cacurpe and are exceptional in their own right, so they can stand alone as superb display examples of this lead molybdate. The really exceptional specimens from this location, however, are heavily encrusted with small, brilliant-orange to red mimetite spherules. These spherules of rich red mimetite are usually about 1/16 inch in diameter, though some are smaller, while others approach 1/8 inch. They are rough-surfaced, but lustrous and an intense color. There are enough spherules on most specimens to provide a delightful and breathtaking contrast with the orange-red wulfenite. The finest specimens of this combination are, in my opinion, the finest wulfenite-mimetite combination ever mined.

Wulfenite and mimetite often occur together, though they do not form a series. The San Francisco Mine is just one example of this association. Arizona has several small, but colorful, rivals to the San Francisco find. The Rowley Mine, near Gila Bend, southwest of Phoenix, is one such rival. The deposit contains a barite chimney deposit. The white barite is heavily fractured and the openings are lined with small, orange wulfenites and orange to yellow micro-crystals of mimetite.

The Rowley has long been a source of minerals for the collector crowd. We'd been going in there since the early 1960s, as far as I know. Now it is being worked for specimens on a commercial basis, so local collectors are no longer able to go underground and find nice specimens. The deposit is a copper, lead deposit, with barite is the dominant matrix rock in some areas.

The fun of collecting at the Rowley is the ease with which you can find nice, small, bright-orange wulfenite blades that almost always had nice, bright-yellow to orange mimetite with them. The mimetite was always a minor member of the two, but its bright color and good coverage always improved the appearance of the wulfenite crystals. Most of the mimetite consisted of tiny, hairlike crystals forming a velvety coating on the white, massive barite. The wulfenite crystals, seldom over inch on an edge, formed either on the barite or on colorful mimetite and are always nicely distributed over the specimen. In the early days of collecting there, you had to choose which open vein you wanted to work, as they all looked promising. All the work had to be done in the ceiling of the main tunnel, where a series of cracks lined with wulfenite could be accessed. Most specimens were thumbnails to miniatures, but always very colorful, thanks to the two minerals.

Rarely, a small galena pod would be encountered in the Rowley Mine, and it always had a halo of secondary lead minerals around it that might include caledonite, cerussite and leadhillite, usually in micro-size crystals.

Now that the Rowley Mine is being worked commercially for specimens, the supply of wulfenite-mimetite minerals has increased exponentially. In addition, since realistic and cautious mining

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methods are being used, including timbering and heavy equipment, larger specimens—some very spectacular—are being extracted.

Another mine in Arizona, far more famous than the Rowley, also yielded the very colorful wulfenite-mimetite association. The Mammoth-St. Anthony Mine in Tiger is famous not only for its superb wulfenite-mimetite combinations, but for its bright green dioptase, snow white twinned cerussite, rich blue diabolcite, equally colorful caledonite, and other rare copper-lead species. The variety of species found here is greater than that of any other mine in Arizona, save for Bisbee.

The mimetite-wulfenite combination at Tiger is a deep orange-red of even richer hue than that of the Rowley material. The Tiger wulfenite ranges up to a deep orange-red, especially when associated with mimetite, which also ranges from deep orange-red to a nearly pure red. The Tiger mimetite spherules are never large, usually under ¼ inch, and most of them smaller. They are always found associated with and even perched on the fine transparent wulfenite blades, which seldom reach an inch. For sheer intense color, the Tiger combination of wulfenite-mimetite is undoubtedly the finest to be found.

Still another Arizona mine, the 79, has produced superb wulfenite-mimetite specimens. Like the Rowley, the 79 Mine was accessible to collectors for years, though entrance to the property was always illegal. Eventually, the mine was leased to a specimen miner, and since then it has passed through a couple of hands, but is still being operated for specimens.

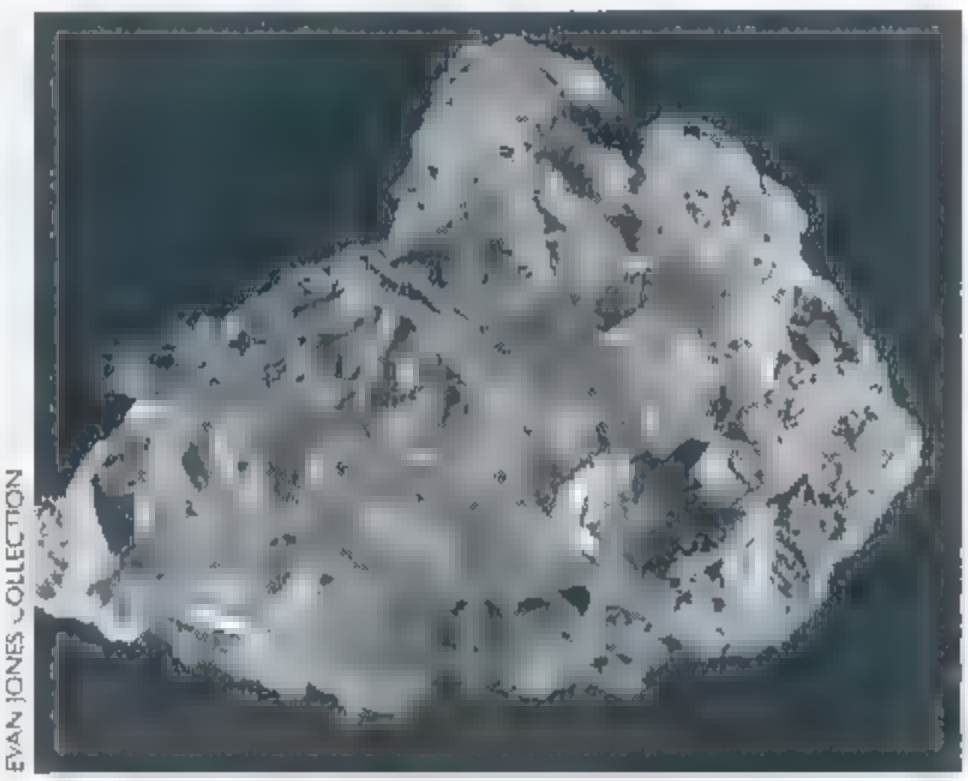
The 79 Mine mimetite forms as velvety crusts and reniform masses and can range in color from orange to orange-yellow to bright yellow. When wulfenite occurs with the mimetite, the combination is superb, as the wulfenite forms fine, tabular, rich-orange crystals on the equally colorful mimetite.

Another source of fine massive mimetite in Mexico is the Santa Eulalia area, not too many miles east of the City of Chihuahua in the State of Chihuahua. The mountains east of that city are shot through with mines. The literature reports Santa Eulalia, Francisco Portillo, and Aquiles Serdan as sources of minerals. These are the small villages where the miners lived. The actual source of these minerals cannot always be determined simply because the specimen miners, who often sneak underground and have favorite specimen areas, will not divulge where they are digging! Then, too, a miner may enter a mine at one entrance and emerge from yet another mine exit, so he may name either mine as the source. Another problem is the occasional re-naming of a village depending on which political party is in power or who is being honored for some daring deed.

There have been three important occurrences of mimetite in the Santa Eulalia district. Francisco Portillo, Aquiles Serdan, and San Antonio el Grande. Francisco Portillo produced lovely tan to brown botryoidal clusters of mimetite in considerable quantity. Because of their less attractive color when compared with the bright yellow Congresso-Leon specimens, these never created the excitement you might expect for any good mimetite.

From Aquiles Serdan, specimen miners brought out a large amount of fine, pale yellow mimetite in hand-size clusters. These are very attractive, but lack the vibrant color of the San Pedro Corralitos specimens. Still, they are fine specimens of tightly clustered, small, grapelike knobs of good color in nice sizes.

The San Antonio el Grande is located on the opposite side of the mountain range from Aquiles Serdan. Of all the mines, it is the most active, still producing ore and, at times, specimens. The latest to come to light is lovely blue botryoidal hemimorphite in very showy pieces.



EVAN JONES COLLECTION

This richly colored combination of mimetite and wulfenite is from the world-famous Mammoth-St. Anthony Mine in Tiger, Arizona.

The mimetite from the San Antonio Mine is the most attractive of any coming from this area. It occurs as bright-yellow botryoidal masses of good size. The structure of the specimens consists of small nodules, most of them under ¼ inch, so the surface of the specimens looks like yellow cauliflower, a quite attractive appearance.

Another source of mimetite in Mexico was at Ojo Caliente, Zacatecas, where mimetite occurred in solid masses up to 3 inches thick. The color of the typical botryoidal masses was a nice yellow to orange. The supply was never as large as that from the Congresso-Leon Mine, most likely because the former source was an active mine where specimen recovery was never a high priority, while the latter mimetite producer was operated for specimens.

The mimetites from Broken Hill, New South Wales, Australia, range in color from yellow to reddish brown. The reddish brown crystals are generally referred to as campylite, as they closely resemble the crystals found in the Caldbeck Fells area in England.

Mimetite was first identified at Broken Hill in 1897. They were found sporadically in the gossan areas, with limonite forming the matrix. Some mimetites are colorless, or nearly so; the more colorful crystals are more popular. The more attractive crystals have a pyramidal termination and the prism faces have what might be called a steplike surface. The only time you'll see a Broken Hill mimetite for sale is when an older collection is sold, since the mine has been shut down for some years now.

Today, some of the more exciting mimetites are coming from China. The Pingtouning Mine in Guangdong Province has been bringing forth lovely yellow hexagonal prisms of mimetite on matrix. Most crystals are rather small, but bright-yellow to orange. Most are striated, and some are even hoppered. The larger crystals reach an inch in length. Most are widely scattered on matrix rather than being tightly intergrown like those from Germany and elsewhere. This makes specimens quite attractive and the crystals are easily studied.

There is little doubt that mimetite will continue to be available for collectors. With the intense mining in China, where new sources of minerals are constantly opening, I'm sure the market will be well supplied by that vast country.

GOLD AND GEM HIGHWAYS

ROADSIDE PANNING SITES IN TEXAS

Part VI: Travis, Trinity, Val Verde, Webb, Wilson, and Zapata Counties

Story and Maps
by David and Clois Walker

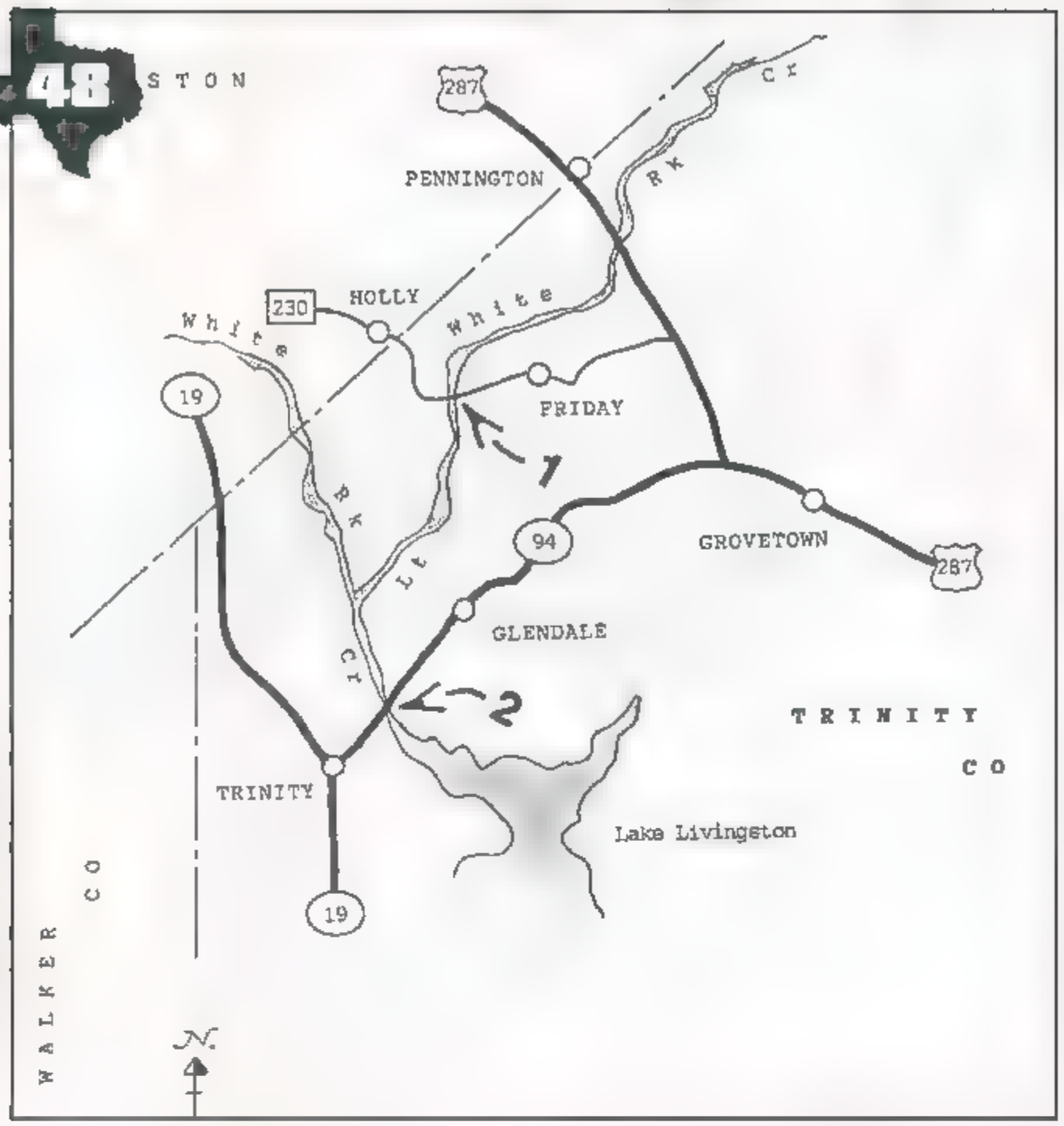
This is the sixth in a series of six articles containing county-by-county maps to suggested panning and screening sites at Texas highway/stream crossings where appreciable finds have been previously reported in vicinity watersheds. The principles of erosion make it likely that minerals and gemstones have been deposited in river gravels, awaiting removal by a rockhound with a pan.

By confining operations to within government-purchased highway rights of way, panners are spared the necessity of locating and obtaining permission from adjoining property owners, including state and national parks and Indian reservations. However, readers run the risk of prosecution if they cross onto private land, whether purposely or inadvertently. In instances where rights of way have merely been leased, other rules may apply. Visitors are urged to inform themselves of possible limitations by calling (512) 225-1462 *before* making a trip. The Annual Vacation Guide, as a companion state source of information, is available by calling (800) 888-8839.

Remember that the government to which these rights of way belong has some regulations of its own. Observe highway safety and environmental standards, such as parking only where designated, and using only a pan and scoop.

The maps provided contain the most up-to date information available to us, but it is advisable to consult a current state highway or county map when planning an outing, for overal orientation in the field and because highway designations have been known to change.

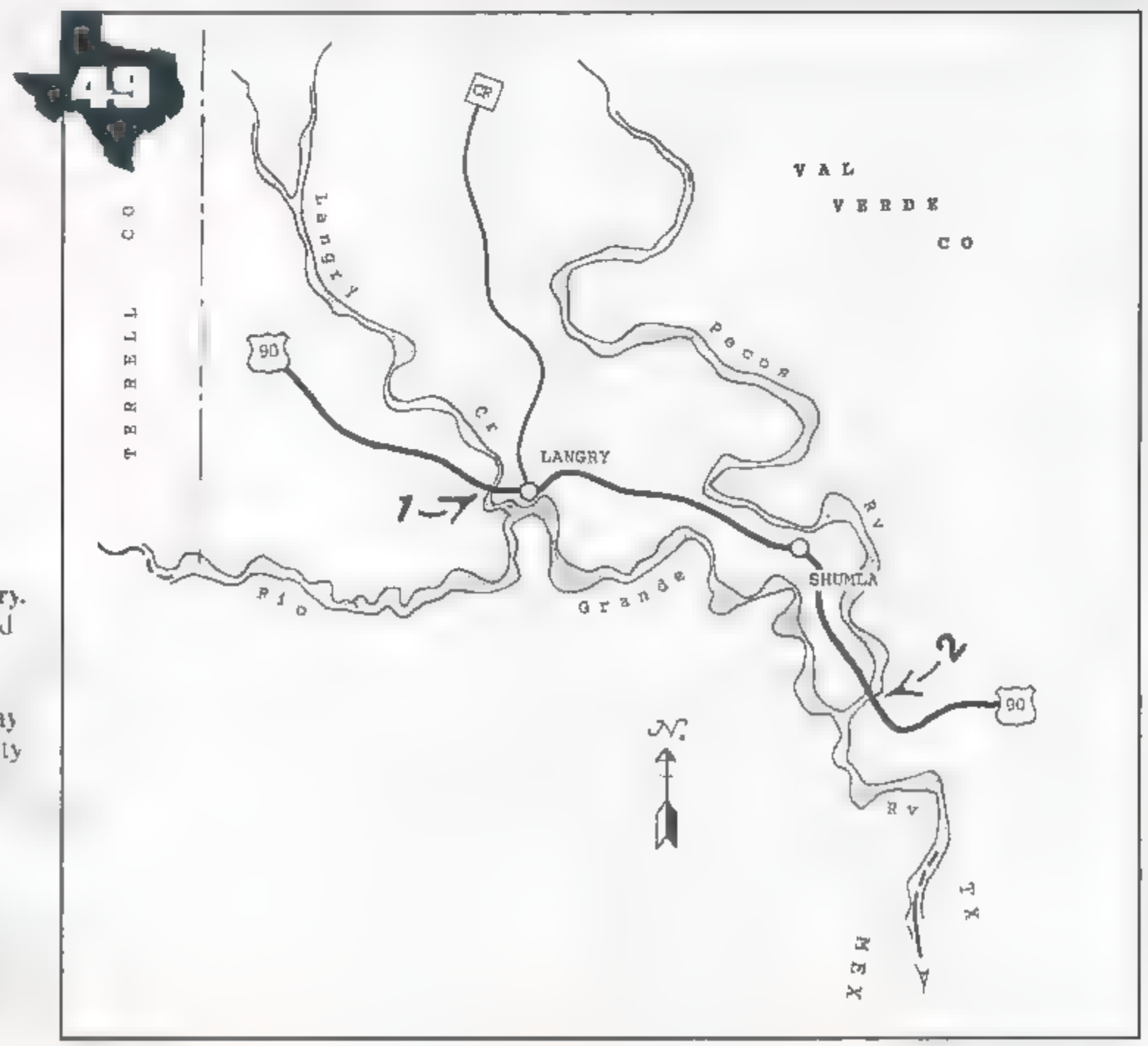
TRAVIS COUNTY (MAP TX47)
Site 1 **Colorado River/FMR 620** crossing near **Marshall Ford.** Vicinity finds include opalized wood, palm wood, and silicified wood.



TRINITY COUNTY
(MAP TX 48)

Site 1. **Little White Rock Creek/FM 230** crossing near **Friday.** Vicinity finds include agate, chalcedony, jasper, and silicified wood

Site 2. **White Rock Creek/state Route 94** crossing near **Trinity.** Vicinity finds include agate, chalcedony, jasper, quartz, opalized wood, palm wood, and silicified wood.



VAL VERDE COUNTY
(MAP TX49)

Site 1. **Langry Creek/U.S. Highway 90** crossing near **Langry.** Vicinity finds include agate and silicified wood.

Site 2. **Pecos River/U.S. Highway 90** crossing near **Shumla.** Vicinity finds indicate quartz potential

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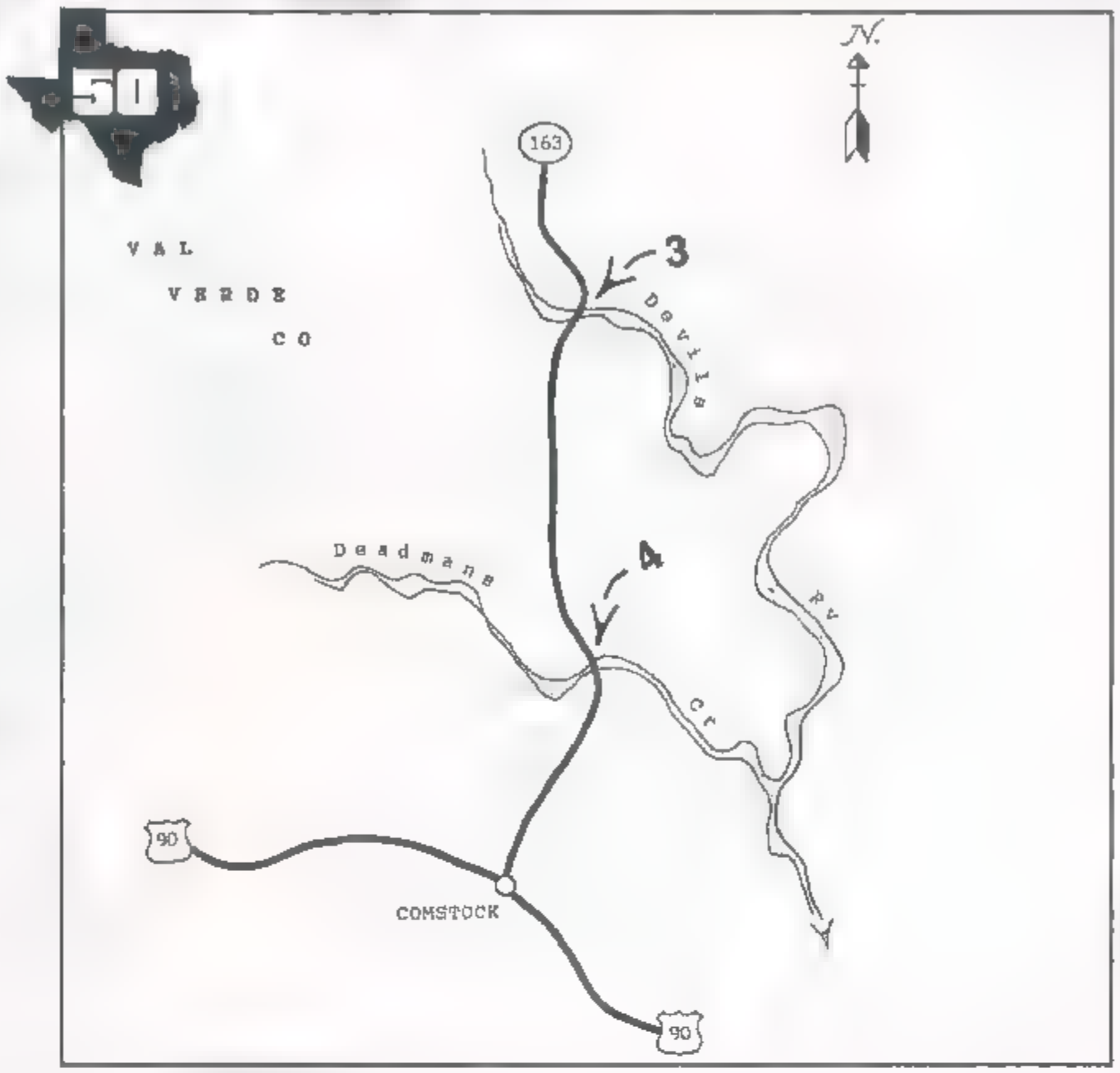
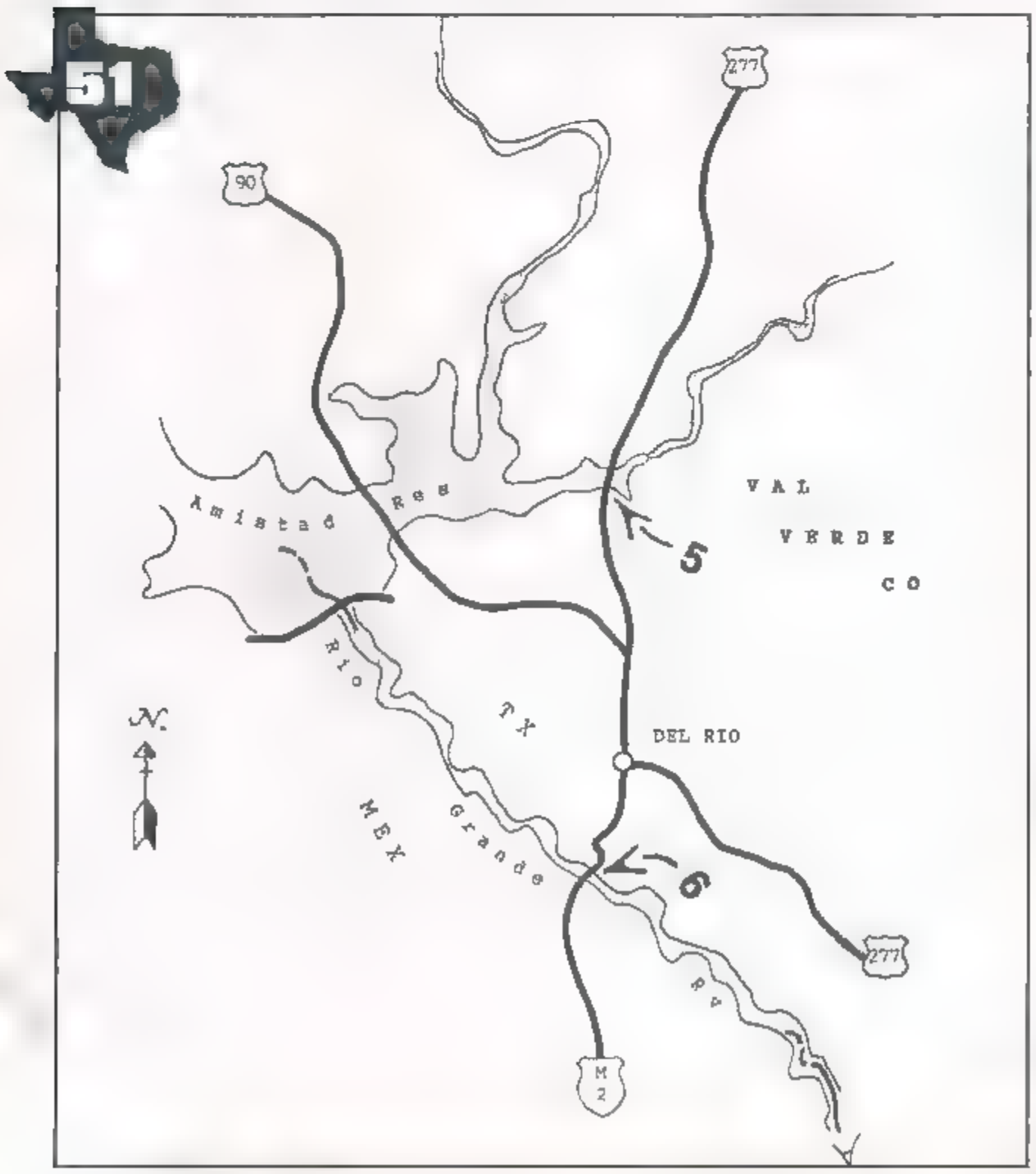


VAL VERDE COUNTY
(MAP TX50)

Site 3. **Devil's River/state Route 163** crossing near **Comstock.** Vicinity finds include agate and quartz.

Site 4. **Deadman's Creek/state Route 163** crossing near **Comstock.** Vicinity finds include agate, chalcedony and quartz.



VAL VERDE COUNTY
(MAP TX51)

Site 5. **Tributary Amistad Reservoir/U.S. Highway 277** crossing near **Del Rio.** Vicinity finds include agate, chalcedony, jasper, and silicified wood.

Site 6. **Rio Grande River/U.S. Highway 277** crossing near **Del Rio.** Vicinity finds include agate, chalcedony, jasper, quartz, and silicified wood.

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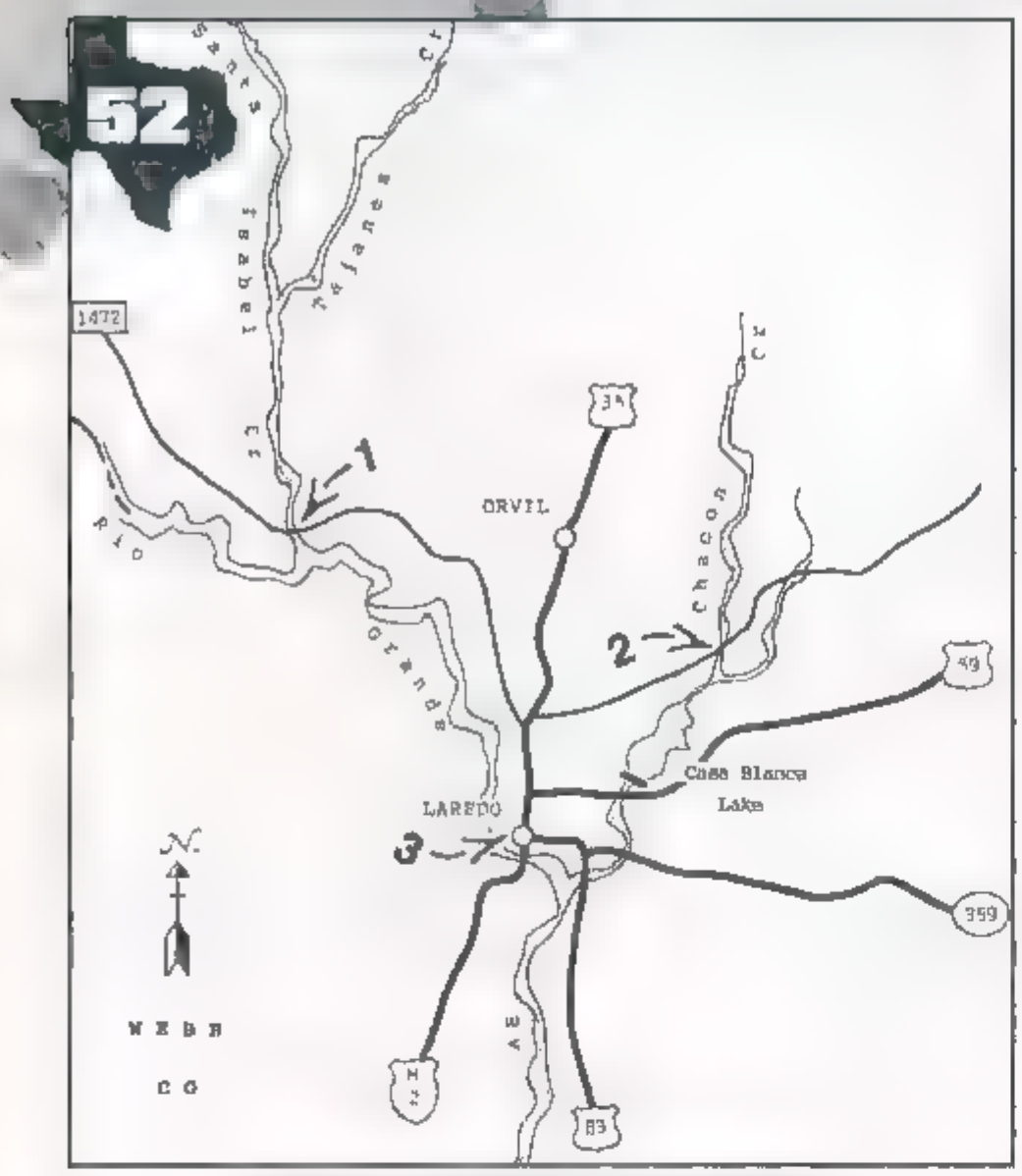
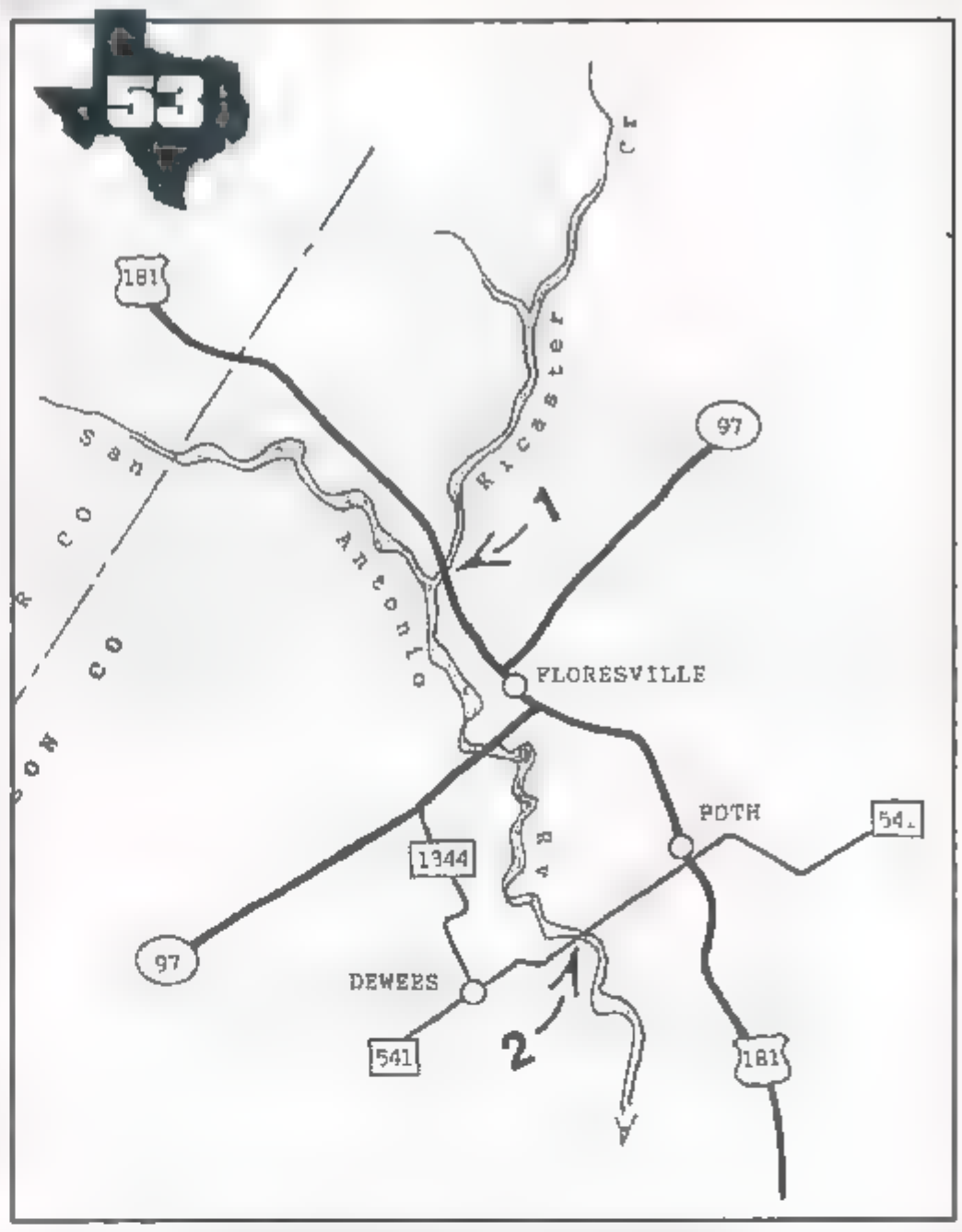


WEBB COUNTY (MAP TX52)

Site 1 **Santa Isabel Creek/FMR 1472** crossing near **Laredo.** Vicinity finds include agate, chalcedony, jasper, opalized wood, and silicified wood.

Site 2. **Chacon Creek/County Road** crossing near **Laredo.** Vicinity finds include agate, chalcedony, and silicified wood

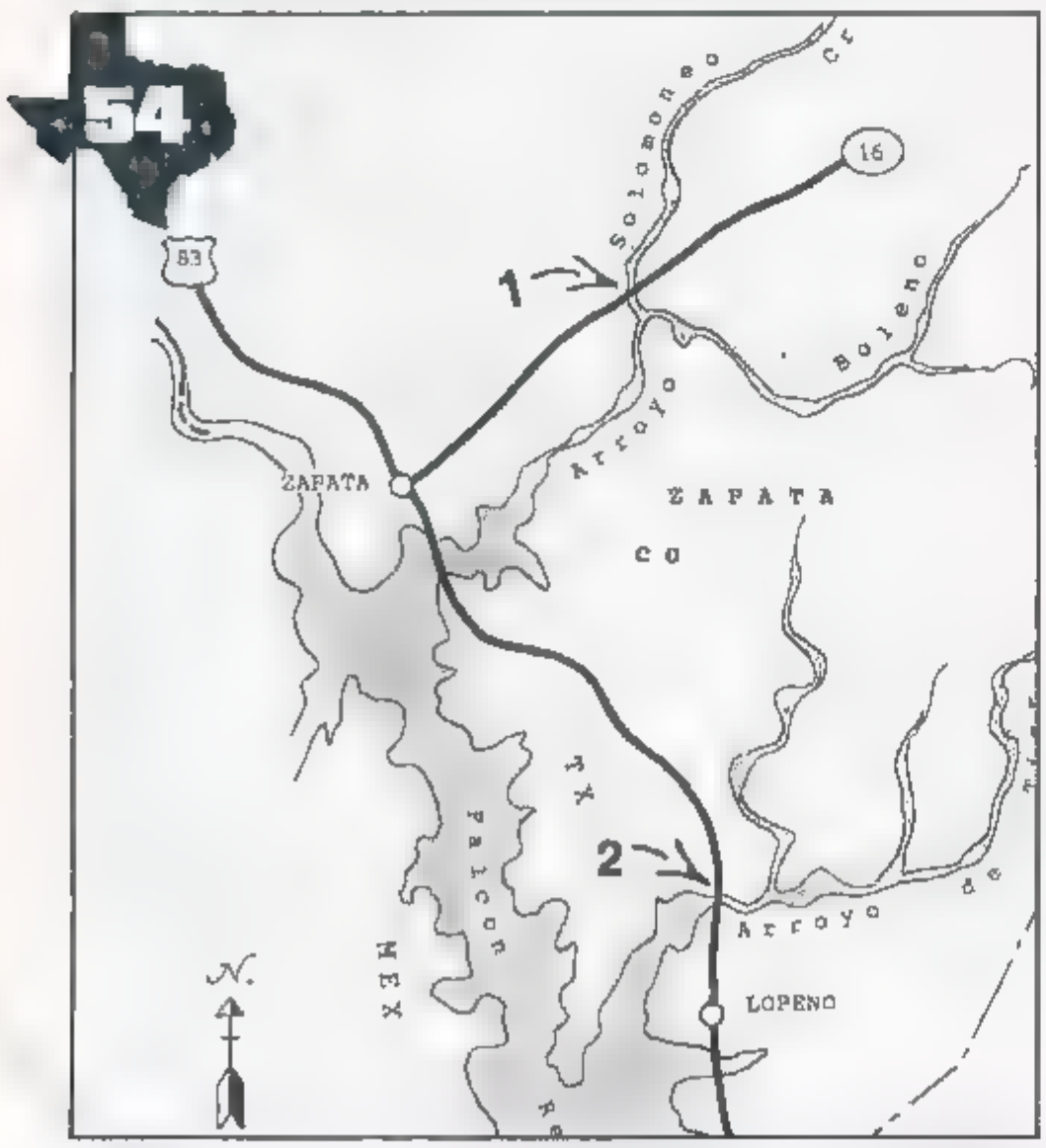
Site 3 **Rio Grande River/U.S. Highway 35** crossing near **Laredo.** Vicinity finds include agate and chalcedony.



WILSON COUNTY (MAP TX53)

Site 1 **Kicaster Creek/U.S. Highway 181** crossing near **Floresville.** Vicinity finds indicate silicified wood potential

Site 2. **San Antonio River/FMR 541** crossing near **Poth.** Vicinity finds indicate silicified wood potential

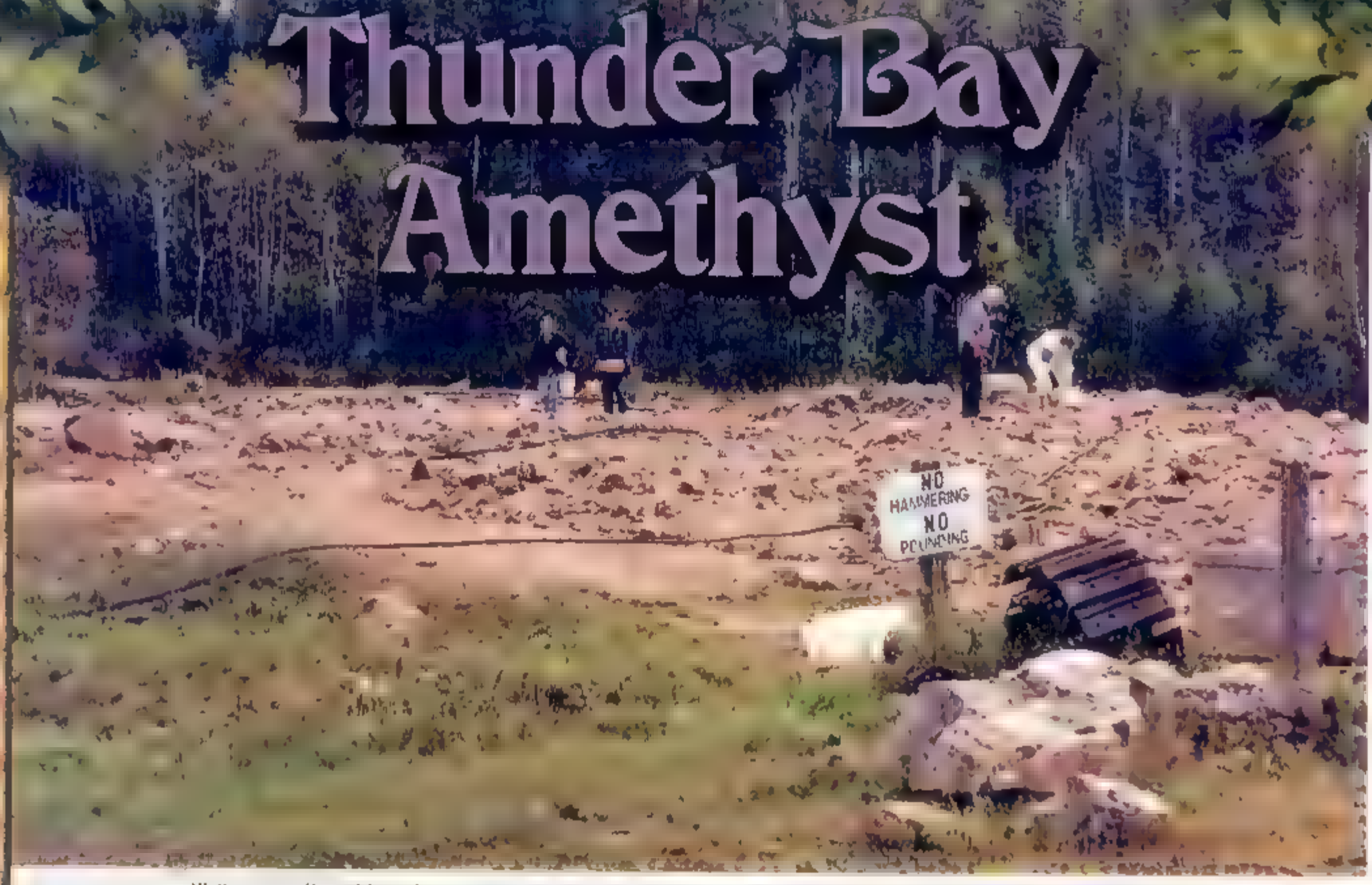


ZAPATA COUNTY (MAP TX54)

Site 1 **Solomoneo Creek/state Route 16** crossing near **Zapata.** Vicinity finds include agate, chalcedony, jasper, palm wood, and silicified wood

Site 2 **Arroyo de Tigre Grande/U.S. Highway 83** crossing near **Lopeno.** Vicinity finds include agate and chalcedony

Thunder Bay Amethyst



Visitors are allowed to pick up specimens anywhere in the mine's five acres, but most people collect in the tailings.

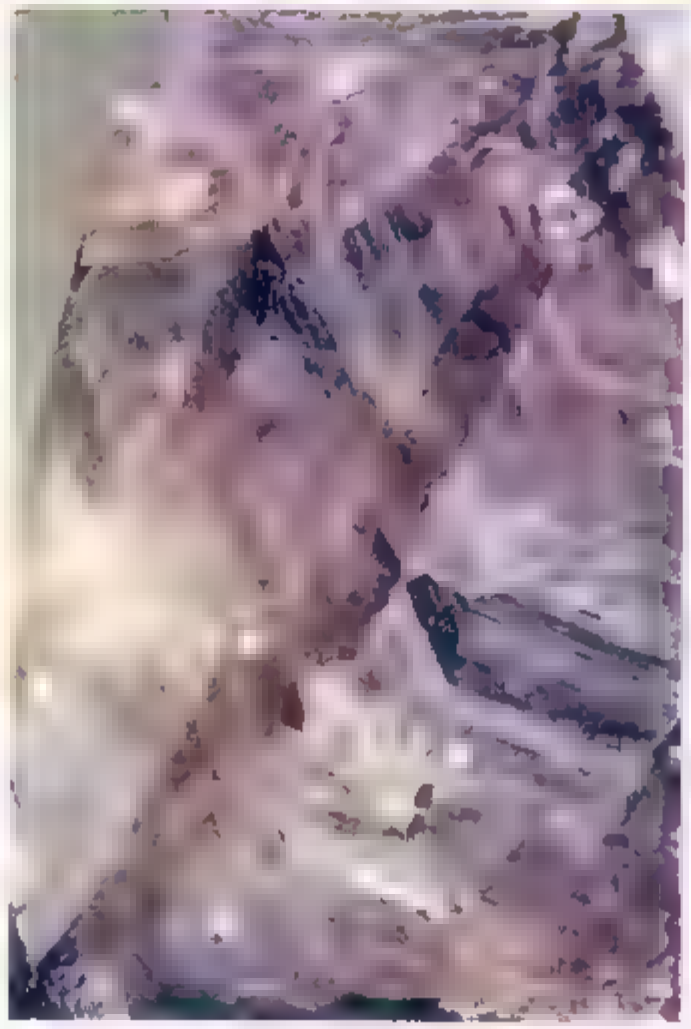
Collecting at Canada's Panorama Mine

Story and Photos by Pat Kerr

I am delighted to say the days of casual collecting are not over. Research and study aid the searcher, but there continue to be vast wilderness areas that are open to searching and, in Canada, annual upheavals from frost and visible changes due to the freeze-thaw cycle bring minerals to light. My aunt helped dig a friend's garden in the center of the city of Thunder Bay and discovered a large vein of amethyst. She isn't the only person to make an accidental discovery.

Hematite sometimes appears like sheets in the crystals, giving the stones an "earthy" appearance.

Amethyst forms in holes called "vugs" or in veins in the granite host rock.



Every amethyst crystal is unique because of zoning and striations that are visible with the naked eye.

Hematite inclusions, although not always visible to the eye, are present in the Panorama Mine amethyst.

Another Thunder Bay accidental discovery is the Thunder Bay agate mine. It was found in 1987. This is the only known vein formation of agate in North America. Veins are 3 feet to 4 feet thick and perfect for carving. This mine is a half mile north of Trans-Canada Highway 17 on Provincial Highway 527, just east of the city of Thunder Bay, but unfortunately, it is closed at present.

According to *The Natural History of Ontario*, "Beneath much of North America lies a vast expanse of hard Precambrian rock, the foundation of the continent. Buried in the Hudson Bay region by a mantle of younger rock it climbs to the surface and is exposed across most of Ontario as the Canadian Shield. Passing under the Great Lakes it is buried again by younger rock." The Canadian Shield is divided into seven structural parts. The amethyst mines are in the Superior province. This is considered the oldest bedrock in the Shield. It has islands of volcanic and sedimentary rock that are surrounded by granite and gneiss. Typically, the islands have metamorphosed into greenstone. There are three categories of deposits: polymetallic deposits (including copper, zinc, silver, and gold ores), gold vein deposits, and iron ore, or iron, deposits.

According to the Geological Highway map distributed by the Ministry of Natural Resources, the present working amethyst mines in the region are in diabase, gabbro, diorite, ultramafic rocks, and granophyre. Another source for geological information is the Ministry of Northern Development and Mines Web site, www.mndm.gov.on.ca. The first amethyst mine in the area was also discovered by accident. Workers were building a fire tower, and their equipment scraped the topsoil and exposed the purple crystals.

Amethyst is only one of the color forms taken by quartz. Colorless quartz is called rock crystal, yellow-brown is citrine, gray to black is smoky, and then there are milky and rose. Quartz, or silica dioxide (SiO_2), is found everywhere on Earth and in every condition. Although the Earth's rocks contain 92 relatively stable elements, silica makes up 70 percent of their content. Quartz makes up 12 percent of the igneous rock, and it averages about 27 percent of granite.

Amethyst's beauty and hardness make it a popular crystal in many cultures. The Jewish high priest wore amethyst on his breastplate as a symbol, experts believe, of the tribe of Benjamin. Greek mythology says Diana had a young girl named Amethyst in a cave, turning her into quartz to protect her from Dionysus. When Dionysus became remorseful, he poured wine on to the crystal and gave it the violet color. Some people suspended amethyst on dog hair as an antidote for snakebites.

We now know the purple color in amethyst develops when iron ions replace silicon ions in quartz. These are ionized with low levels of natural radiation. The iron ions align, and we see purple. Color zoning makes every amethyst crystal unique. According to the Ministry of Northern Development and Mines Web site, "Layers of different colors [are] caused by the changing compositions of the fluids that formed the amethyst."

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Amethyst is the official gemstone of South Carolina, Uruguay, and Ontario, Canada. Ontario claimed the stone in 1975 to encourage and recognize the northern economy. It is the birthstone for February and the traditional gift for the 17th anniversary. Legends assert that the stone will quicken and protect, guard against disease, bring peace of mind, and control evil thoughts. The Greeks believed drinking from an amethyst cup would prevent drunkenness. The word amethyst is from the Greek for "not drunken" or "sober."

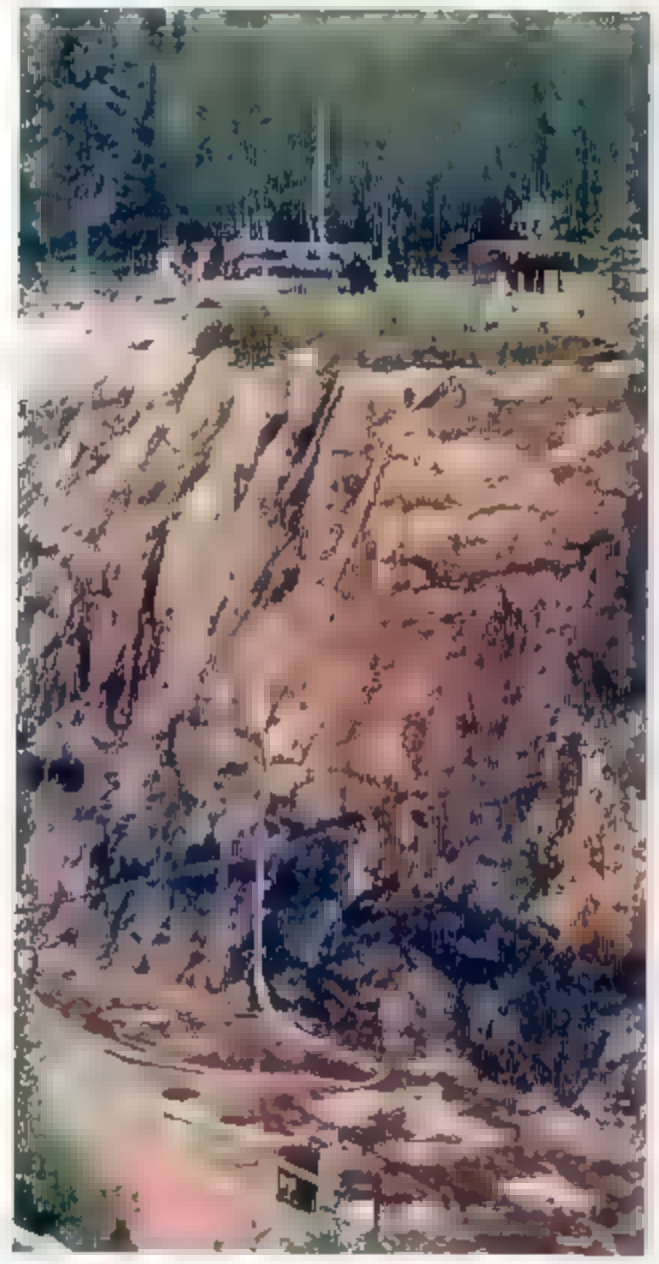
Geologists use quartz as a geological "thermometer" to judge the temperature when the crystals were formed. Below 573 degrees Centigrade, the crystals are right- or left-handed rhombohedral. Webster's dictionary defines a rhombohedron as "a parallelogram whose adjacent sides are unequal and whose angles are not right angled." Above 573 degrees Centigrade, the crystals are paired or fully developed rhombohedral. Above 870 degrees Centigrade, the crystals are orthorhombic, in which three unequal axes intersect at right angles (a right-angled parallelogram). Finally, above 1,470 degrees Centigrade, they are white cubic-system crystals, or cristobalite.

My husband and I have different personalities. I love the chance discovery and will wander for hours digging here and there, providing opportunity for luck. He wastes no time and immediately works to discover the best way to find perfect crystals. So when we arrived at the Panorama Mine site, he worked in the tailings, beginning with the hoses that were scattered and running on the mounds of stones, chips and fragments. The guide had told us that pressurized water would smash the crystals apart, so he allowed the water to puddle and, with his hand, dug a miniature stream from the puddle, allowing the sand to wash away. He then moved the hose, allowed the water to drain away, collected the exposed rocks, and repeated the process.

At the Panorama site, miners do the heavy blasting and use pressurized hoses to open the bedrock granite of the Shield. The tailings are mounded at one side, forming a 200-foot-square pile of mixed rock with amethyst in small pieces. Samples about 6 inches to 12 inches in diameter are piled on tables, and large pieces weighing tons are at the entrance. All are sold for a couple dollars per pound. The only limitations placed on casual hunting on the property are no searching in the mine and no pounding. Since I couldn't pound to release the samples I found, I got some exercise and my husband got a bucketful of amethyst.

Quartz has a hardness of Mohs 7, so it is unlikely that we could manually break the crystals, but this mine is located in an area with red hematite (Fe_2O_3). Hematite has a hardness between Mohs 1 and Mohs 6.5 and fractures conchoidally, so I expect this is what the guide was trying to tell us. I was told this is the only known area in the world where hematite actually colors the amethyst, but I believe this is false. We found what appeared to the naked eye to be both clear amethyst and the earthy-colored hematite crystals. However, as seen under magnification, all the crystals we carried out had hematite inclusions or a thin coating of hematite. Amethyst is allochromatic. It is known to contain smoky or yellow parts among the violet or clear portions.

Samples of amethyst are displayed and sold in the mine's store



The Panorama Mine is an open-pit, labor-intensive mine.

Driving to the mine from Sault Ste. Marie, Canada, along Trans-Canada Highway 17, we were startled to notice dramatic changes in the geography as we crossed the top of Lake Superior. We passed in and out of several geographic and climate zones due to glacial and volcanic activity and the moderating effect of Canada's largest lake. The area is a rockhound's paradise, and at many picnic areas you can see evidence of collectors who apparently were in search of everything from rose crystal to iron ore to gold ore.

There are three basic types of vacant land in Northern Ontario: private land, parks, and crown land. It is illegal to collect anything in parks or on private land, unless you have the landowner's permission. Crown land is available for use at your own risk. Canadian citizens may camp without charge on crown land, but all others require permits. The entrances and exits of all the parks are clearly posted, but distinguishing crown land from undeveloped private land is challenging. Some clues to indicate private land are a fence in any state of repair and/or red dots painted on trees or signs. Road allowances, except in park areas, follow the same rules as crown land.

continued on next page

Thunder Bay Amethyst *from page 43*

The road to the Panorama amethyst mine is red with hematite.

As you approach the town of Red Rock, you will notice some spectacular examples of red hematite outcrops from the road. Continuing around Lake Superior and about a half-hour from Thunder Bay, you pass signs advertising the Ontario Gem Mining Co. mine to the south. The signs advertise a level entranceway and a Graduate Gemologist and jeweler on the premises, and say you can actually enter the mine site, but without tools. A few miles farther on, turn right on East Loon Road. It is well signed up the hill to the Panorama Mine. The gravel road is about 7 kilometers long, steep, and winding. We used four wheel-drive to reach the top with a trailer, but we saw standard cars make it safely. The Panorama Mine Web site (www.amethystmine.com) has a map to the site. Blue Points Amethyst Mines are north on Pearl Road 5 from Pass Lake.

When the Panorama Mine opened, the investors had dreams of great riches. It is considered the largest amethyst deposit in North America. The veins in the area run parallel and subparallel to the Kewee tawan fault. However, amethyst is too common to be considered a precious gem.

The Panorama Mine, like many of the mines in the Canadian Shield, was found by accident. It has produced steadily since 1960, and 40 percent by volume of the amethyst is usable. Mining amethyst is labor intensive, samples are difficult to remove intact from the surrounding granite. At the mines, jackhammers and explosives were originally used to remove the surrounding rock. Then high-pressure hoses revealed the amethyst, but picks, shovels, and hand labor painstakingly removed each chunk. Now, miners use small dynamite charges to loosen the host rock. This avoids unnecessary damage to the crystals. The amethyst from the Panorama Mine is primarily sold through the Amethyst Gift Center in Thunder Bay, where craftspeople create jewelry and decorative items from it. Other stones are shipped to China for carving. The completed wares are returned and sold in Thunder Bay.

Superior province is rich in mineral deposits and there is so much more to discover by accident or careful study. The days of casual collecting are not over. Whether you are searching for gold, amethyst, or the unimaginable wealth of the Shield, it's the place for rockhounds."

FOR MORE INFORMATION

Contact the following sources for more information about amethyst or mines:

The Panorama Mine
(807) 622-6908
www.amethystmine.com

Ministry of Northern Development
www.mndm.gov.on.ca

Ontario Gem Mine
P.O. Box 7 Rte. 1
Dorion, ONT P0T 1K0

Thunder Bay Agate Mine
(807) 683-3595
www.agatemine.com

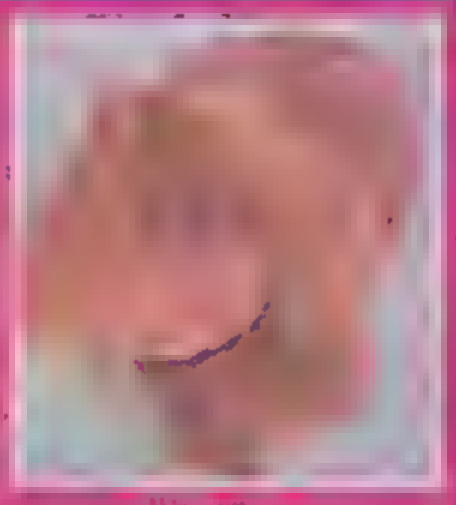
Blue Points Amethyst Mines
lynswan@lakenet.com

ROCK & GEM

What Makes a Mineral Specimen Valuable?

KIDS

Desert Roses



Rock & Gem Kids Quiz

The *Rock & Gem* Kids Quiz contest is open to U.S. residents age 18 and younger. All these questions can be answered by carefully reading this column. Write your answers neatly on a postcard or 4X5 card and mail to **Rock & Gem Kids Quiz, P.O. Box 6925, Ventura, CA 93006-9899.** Valid entries received by **July 31, 2006** will be entered in a drawing from which five winners will be chosen. Valid entries must be the entrant's own work and must include the correct answers, the entrant's name, age and address, and the signature of a parent or guardian. Prizes are generously provided by the Arizona Mineral and Mining Museum Foundation.

1. Selenite roses form from the mineral _____.
2. _____ is a type of quartz with extremely tiny crystals.
3. Chalcedony roses that are stained with layers of iron oxide are called _____ _____.
4. Three factors that make a mineral specimen valuable are _____, _____ and _____.
5. The law of _____ _____ _____ states that rare specimens sell for high prices.

STAY OUT AND STAY ALIVE

Abandoned Mines Pose a Danger

Story and Photos by Steve Voynick

In their lists of favorite field-collecting localities, many mineral collectors include an abandoned mine site or two. That's to be expected, since mines are often sources of specimens that cannot be found elsewhere. Many old mine sites offer, or offered, two different approaches to mineral collecting: search through the surface dumps, as most collectors do, or go underground to hopefully find better specimens.

Until recently, a good example of the latter was Arizona's Tonopah-Belmont Mine (a.k.a. the Belmont-McNeil Mine, referring to its entrance through the McNeil Tunnel). Roughly 60 miles west of Phoenix in the Osborn Mining District of the Little Horn Mountains, the Tonopah-Belmont is perched on the brown, barren slopes of Belmont Mountain .5 miles north of the Interstate 10 Tonopah exit.

Despite its remote location, the Tonopah-Belmont has never lacked for visitors, many of whom come to collect specimens of the more than 50 minerals that have been identified at the site. The Tonopah-Belmont once exploited both the oxidized and sulfide sections of a network of mineralized veins that lace the andesite country rock. The mine produced gold, silver, copper, lead, and zinc from such primary ore minerals as native gold, galena, chalcopyrite, sphalerite, and two silver sulfides.

Other collectibles at the Tonopah-Belmont include anglesite, aurichalcite, chlorargyrite, hemimorphite, hydrozincite, mimetite, pyromorphite, smithsonite, vanadinite, and wulfenite. The surface dump, which is well known for nice micromount specimens, is also the type locality for the rare mineral becherertite, a basic copper zinc silicate sulfate that occurs as slender, light-green prisms.

Thousands of open shafts across the West have been sealed off and made safe.

After producing sporadically for nearly 80 years, the Tonopah Belmont Mine finally closed in 1942. In keeping with land-use concepts of the time, the mine was simply abandoned. When the last of the Tonopah-Belmont miners walked away, they left the dump and the underground workings wide open to everyone.

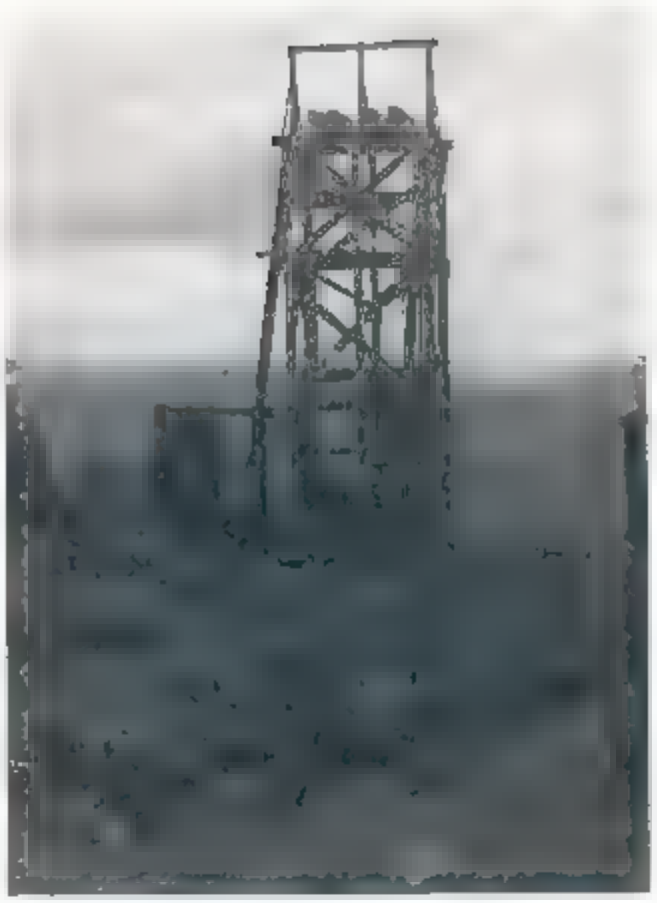
Over the years, the abandoned Tonopah-Belmont became a popular and productive mineral-collecting site. Mineralogical literature makes numerous references to collecting both on the dump and within the mine itself, where fine specimens are found in the exposed "main vein."

But while the underground of the old Tonopah-Belmont did yield a variety of fine mineral specimens, it also provided something else: a high level of danger. This was made plain in 1990, when a young man set out to explore the mine workings. He made his way through the McNeil Tunnel where, in the dim light some 100 feet beyond the portal, he stumbled upon a type of mine working that he may have been unfamiliar with: a winze, a vertical, internal shaft that accessed the lower mine levels. Somehow, he fell into the winze, meeting his death in the darkness 350 feet below.

A few years later, the state of Arizona, as part of its program to limit access to some of its thousands of abandoned mines, sealed off the Tonopah-Belmont portal with a metal grating. But in June 2002, another visitor, also intrigued by what might be inside the old mine, pried apart the protective metal grating just enough to squeeze through. Proceeding along the McNeil Tunnel, he met exactly the same fate as the mine's previous victim. This tragedy gave the old Tonopah-Belmont Mine an unusual distinction: More people had died in its underground workings *after* it had closed than during all the years it had operated.

The Tonopah-Belmont Mine is just one of an estimated 150,000 abandoned mines, ranging from shallow surface diggings to deep, multilevel, underground workings, scattered across the United States. During the last 50 years, these old mines have claimed the lives of at least 1,000 people and have seriously injured many more. Because the fragmented ownership of abandoned-mine lands by private, corporate, county, state, and federal entities makes accurate accounting difficult, the actual fatality numbers are probably much greater.

Despite the efforts of states to restrict access to abandoned mines, a growing population and subsequent greater recreational use of backcountry areas have driven annual fatality rates higher. During the five-year period between 1999 and 2003, at least 135 people died in abandoned mines, 28 in 2003 alone.



The condition of the headframe at abandoned mines is no indication of the condition of the shaft.

Nevertheless, despite the obvious risks, abandoned mines continue to attract mineral collectors, hikers, backcountry explorers, adventurers, treasure hunters, and the generally curious, few of whom realize the nature or the true extent of the dangers confronting them.

My awareness of, and respect for, abandoned-mine hazards stem from personal experience as a field mineral collector and as a former hardrock miner. I believe that it is difficult, if not impossible, for a person without underground mining experience to realistically identify, assess and understand the dangers present in abandoned mines. The dangers in operating maintained mines are considerable, yet nothing compared with those waiting in abandoned mines.

Before being sealed off, this 1885 mine had a badly eroded collar and a 350-foot drop.

With the exception of private property trespassing laws, no laws specifically prohibit entry into abandoned mines. That leaves public education as the only effective way to reduce the annual abandoned-mine death and injury toll. And in this area, the U.S. Bureau of Land Management (BLM) has taken the lead. The BLM has good reason to be concerned about abandoned mines because there are tens of thousands of them on the 420,000 square miles of land that it administers. In 1993, the BLM established its Abandoned Mine Land Inventory System (AMLIS) to locate, survey and assess the danger levels of its old mines. To date, the BLM has cataloged and investigated nearly 12,000 abandoned mines. Although this represents only a fraction of all the old mines on BLM lands, it does include many of the most accessible and dangerous sites.

The BLM's "Stay Out and Stay Alive" program publicizes abandoned-mine dangers, which it groups into six categories: open shafts, unstable rock and decayed support structures, deadly gases and lack of oxygen, explosives and toxic chemicals, becoming lost and disoriented; and highwalls. Every mineral collector should be well aware of each of these potential dangers.

Open Shafts (and Portals): Shafts, or vertical workings that open to the surface, are by far the greatest danger in abandoned (and active) underground mines, accounting for 90 percent of all accidents and entrapments. Collars, the tops of shafts, are especially hazardous because exposure to the elements often erodes the adjacent ground and rots the collar timbers. The leading cause of shaft-related accidents is succumbing to the human temptation to peer into the mysterious darkness of a shaft. Keep in mind that splintered timbers and rusted water and compressed-air pipes protrude from the walls of many old shafts and that the shaft sumps (bottoms) can be flooded. Should collar timbers or adjacent ground give way, or if a person loses his or her balance, the resulting fall, whether only a few dozen feet or hundreds of feet, is often fatal.

Even very shallow shafts can be death traps if no one is around to help. In May 2003, in Colorado's historic Cripple Creek gold-mining district, a lone hiker fell into a 24-foot-deep shaft. He survived the fall, but broke some ribs. Because the nearest traveled road was more than a half-mile away, calling or waiting for help was futile. A day or two later, with the last of his strength, he took his life with his handgun. Although his death was officially declared a suicide, it was, in effect, an abandoned-mine fatality.

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Portals, the entrances to mine tunnels, pose dangers similar to those of shafts, but without the risk of a vertical fall. Old portals usually have rotted timbers and eroded, unstable adjacent ground. Because portals are highly prone to caving, they are the last section of an underground mine that you would want to have between you and daylight.

Unstable Rock and Decayed Support Structures: A big danger in abandoned mines is falling rock or, in mining parlance, "rockfall." Never equate underground mines with limestone caves. Unlike mines, limestone caves are natural chambers many thousands of years old that are chemically and physically stable. While spelunkers sometimes become lost or disoriented in caves, they are rarely, if ever, endangered by rockfall.

On the other hand, rockfall in mines — even operating mines — is rather common. In undisturbed subterranean rock, stresses and pressures are distributed equally, but mining creates artificial underground voids that upset this equilibrium and direct rock stresses inward. Because these stresses actually relieve themselves sooner or later in rockfall events, many mines require some form of ground support such as timbers, rock bolts, shotcrete, or bolted steel matting or screening.

Chemical oxidation also contributes to rock instability, especially in metal mines with an abundance of pyrite or metal-sulfide ores. By exposing these sulfides to atmospheric oxygen and water, mining initiates or accelerates their oxidation. By subsequently weakening the structural integrity of the rock, oxidation can be a direct cause of rockfall.

Caving, of course, can make some abandoned underground mines completely impassable. But even the floors of passable mines are often littered with rocks that fell from the ribs (walls) or the back (roof), a sure indication that more can fall at any time.

Countless television and motion-picture dramas have created a popular misconception of just how rockfall occurs. Overhead rock usually does not audibly crack, timbers do not groan, and small rocks do not sift down ominously as telltale warnings of imminent rockfall. In real life, rockfall is unannounced, instantaneous, and over before anyone even realizes that it has started.

Never trust or disturb old ground-support systems that were originally installed to stabilize the ground and prevent rockfall. Over time, timbers can rot and the acid produced by oxidation can actually dissolve steel rock bolts. Just because old ground-support systems are still in place, there's no guarantee that they still contribute to rock stability. Remember, too, that early miners were rarely concerned with safety; in their zeal to achieve speed and cut costs, they often minimized or ignored ground support entirely.

Deadly Gases and Lack of Oxygen: Miners refer to the potentially lethal conditions of deadly gases and lack of oxygen as "bad air," meaning air that will not sustain life. The most common problem in underground mines is depleted oxygen levels that are frequently caused by oxidation of sulfide minerals, especially pyrite. Pyrite, the most abundant of all sulfides, occurs in quantity in virtually every metal mine. Pyrite oxidation consumes oxygen rapidly and can deplete oxygen levels in unventilated mines to dangerously low levels. Decay (another form of chemical oxidation) of organic matter such as timbers or animal carcasses also consumes oxygen.

Given the number of abandoned-mine deaths recorded annually, collectors should take seriously any warnings of danger.

The initial symptoms of oxygen deprivation — labored breathing, general weakness, and light-headedness — are similar to those of normal fatigue. The inability to identify the cause of these symptoms resulted in a 1999 fatality in the old gold-silver mining district of Lake City, Colorado, when a man, his son, and a friend entered an old mine to search for mineral specimens. Some 600 feet into the tunnel, the friend and the son suddenly felt light-headed. They turned back, while the father continued on. The rescue team that later recovered the father's body attributed the death to suffocation. Normal air contains nearly 21 percent oxygen, but in this unventilated mine, sulfide mineral oxidation had depleted the oxygen level to a mere 4 percent.

Weakness induced by oxygen deprivation can make it impossible to get out of a mine. In September 2003, near Carson, Washington, a physically fit young man rappelled down an abandoned mine shaft while his friends watched from the collar. Not far into the shaft, he began complaining of shortness of breath. His friends urged him to climb out immediately, but he was unable to do so and soon lost his grip on the rope. The leader of the team that later recovered his body at the bottom of the 125-foot-deep shaft attributed his fall to weakness caused by oxygen deprivation.

Another potential underground hazard is the accumulation of methane (CH_4), a tasteless, odorless gas generated by the decomposition of organic matter. Methane is present in most coal mines and sometimes in uranium mines that exploit ores in sandstone that is rich in organic matter. While methane is nontoxic, it displaces oxygen from the air of unventilated mines. And when mixed with certain proportions of air, methane is both flammable and explosive. Accordingly, methane is a major safety concern in operating coal mines, which employ forced, high volume ventilation to prevent its accumulation. But in unventilated mines where methane has accumulated, a single spark or an open-flame light source can trigger an explosion.

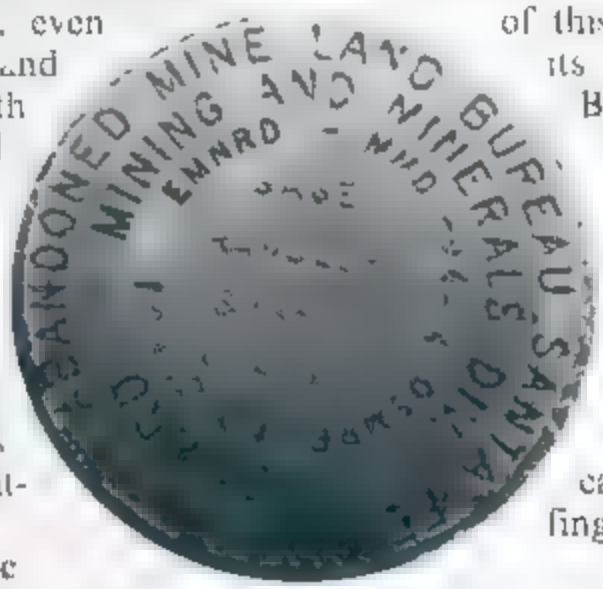
Exploring old mines by the light of matches, candles, and makeshift torches is especially foolish. Not only are open-flame light sources unreliable and prone to sudden failure, they also contribute to oxygen depletion. But should someone with an open light source encounter a methane pocket, those first two dangers won't matter much anyway.

Open flames of any kind also produce carbon monoxide (CO), which can quickly accumulate in underground mines. Carbon monoxide is tasteless, odorless, and so poisonous that concentrations of just 100 parts per million can be lethal. Don't ever start a fire in an underground mine, and never enter a mine that shows any signs of recent fire.

Another form of bad air involves high levels of radon often found in old, unventilated uranium mines. A tasteless, odorless, invisible gas, radon is part of the uranium nuclear-decay chain. Radon isotopes, called "daughters," are intensely radioactive and emit alpha, beta and gamma radiation. In the late 1940s and '50s, miners routinely breathed air with high radon lev-

els while working in the many small, underground uranium mines in the Four Corners region of Utah, Colorado, and northern Arizona. Their subsequent high lung-cancer rate is one of the great tragedies of American mining. Today, the Four Corners region has hundreds of abandoned, underground uranium mines. With the mines unventilated for decades, the air in many of them contains radon accumulations thousands of times higher than the maximum safe levels now permitted in operating mines. While breathing air with very high radon levels is not an immediate hazard, it can exact a terrible toll later.

Beware also of the water in abandoned mines. In pyrite-rich, metal mines, drainage water, even though it may be clear and cold, is often laced with both sulfuric acid and high loads of dissolved, toxic elements such as cadmium, lead, selenium, and arsenic. Mine drainage water can sometimes have a pH as low as 3.0, which makes it about as acidic as battery acid.



The Mining and Minerals Division of New Mexico's Abandoned Mine Land Bureau placed this marker at the new concrete collar that now seats the old Gage Rambler Shaft in the Victorio Mining District.

Explosives and Toxic Chemicals: Abandoned mines and their adjacent mill sites sometimes contain toxic or corrosive chemical reagents that were used in milling or assaying procedures. Gold mines and mills are particularly notorious for this. Old chemicals can include mercury used in amalgamation-recovery processes, potassium and sodium cyanides used in early vat leach extraction processes, and acids and chlorine-containing compounds that generated chlorine gas for chlorination-extraction processes.

Old explosives can constitute an even greater danger. Black powder (blasting powder) is usually found only in older mines. As a deflagrating explosive that merely burns rapidly, black powder must be confined, as in a plugged drill hole, to create an explosion. Because it is hygroscopic and absorbs atmospheric moisture, old caches of black powder occasionally found in early mines will most likely be wet and decomposed and pose minimal danger.

But that's not the case with dynamite, which replaced black powder in most mines in the 1870s. Unlike black powder, dynamite is a detonating, or "high," explosive that normally requires a high-explosive shock, such as from blasting caps, to detonate. Because of its extreme detonation speed, confinement is not necessary to create an explosion. Early dynamites consisted of liquid nitroglycerin mixed with inert filler materials to reduce the nitroglycerin's high shock-sensitivity to manageable levels. Time, heat, or repeated freezing and thawing can separate the nitroglycerin from the filler, which is why old dynamite sometimes drips a syrupy, yellowish liquid. This liquid is straight nitroglycerine, which can detonate with only a mild mechanical shock, such as a sharp tap from a rock pick.

Until the 1920s, the blasting caps used to detonate dynamite contained shock-sensitive, high-energy mercury fulminate. Partial decomposition of this compound increases its shock sensitivity. Blasting caps look like small, metal-jacketed firecrackers that have either a dangling pair of wires or a hollow end to accept a black-powder fuse. Despite their diminutive size, detonating caps can easily remove fingers or take out eyes.

In the 1950s, most nitroglycerine-filler dynamites used in mining were replaced by such modern explosives as ammonium nitrate-fuel oil (ANFO) "prill" mixtures and safer, more stable gelatin and emulsion "stick" high explosives. But tampering with any type of explosives in abandoned mines is just asking for trouble.

Becoming Lost and Disoriented: "Just go back the way you came in" seems like a surefire way to quickly and safely exit an underground mine. Yet in the directionless darkness of the underground, "getting lost" is not uncommon. Some mines, particularly large stoping or caving operations, often have complex systems of interconnected haulage drifts, but the workings of other mines can follow the erratic wanderings of mineral veins with no discernible pattern. Never rely on an assumed sense of direction in the underground. A traditional initiation ritual in operating mines is to lead inexperienced "new hands" off into a maze of dark haulage drifts and leave them there. Even with bright modern cap lamps, not every new miner can find his way back without help. But getting lost in an abandoned mine is no laughing matter.

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Stay Out and Stay Alive *from page 61*

Highwalls: At abandoned surface mines such as open pits, quarries, and placer workings, vertical cliffs called highwalls are the biggest danger. Because they are exposed to the elements and often consist of weathered rock or unconsolidated sediments, highwalls of any height can be unstable.

In 1998, a highwall collapse killed a recreational gold miner near central Colorado's Leadville Mining District. This site had been worked by a floating, bucket-line gold dredge in the 1920s, and a 10-foot-tall highwall of tightly packed, but unconsolidated, gravel marked the perimeter of the dredged area. Recreational gold panners had dug out a foot-thick strata of pay dirt near the bottom of the highwall, and years of undercutting had made collapse inevitable. When that finally happened, tons of highwall material buried a gold panner, who died before he could be extricated.

As a final consideration, would-be abandoned-mine explorers should remember that should things go awry, rescue may be neither attempted nor possible. Few county and municipal search-and-rescue organizations are trained or properly equipped for abandoned-mine rescues. In the past, this work was largely handled by professional mine-rescue teams that were maintained by mining companies. But with the general demise of domestic underground metal mining, fewer mine-rescue teams are active today.

When a young man fell into a deep shaft in Colorado's Cripple Creek gold-mining district in 1986, rescue was not even attempted because of the great depth and extremely poor condition of the shaft. Although the fall had been witnessed, the family's subsequent request for a death certificate was twice refused for lack of a body. Fourteen years later, authorities managed with difficulty to lower a remote camera 1,000 feet to the bottom of the old shaft to capture video images of victim's remains. When clothing colors confirmed his identity, the death certificate was finally issued. The shaft was then sealed and a small bronze plaque placed at the collar in memory of its victim, still at the bottom.

Since 1990, several thousand abandoned mines have been "made safe" by state geological and mining agencies by fencing off workings, filling in shafts, blasting shut or otherwise sealing portals, or installing steel or aluminum gratings. But sealing off abandoned mines sometimes creates secondary problems. One concern is that simply blasting shut or otherwise "plugging" portals can divert polluted mine-water outflows into subterranean water tables. Another addresses the ecological destruction of bat habitat and has resulted in growing use of "bat permeable" metal gratings to close off mine openings.

This old underground mine has been closed off by a massive metal screen across the portal. Specimens can be safely collected on the nearby dumps.

Do not confuse abandoned mines with public mine tours, dozens of which exist in the western states. These commercial attractions, many more than a century old, are subject to regular, mandatory visits by state mine inspectors. These mines must comply with all state regulations regarding rock stability, air quality, ventilation, and general underground safety, and are quite safe and enjoyable to enter.

My purpose in writing this article is not to give readers any false sense of confidence in their ability to recognize and assess abandoned-mine hazards, and thereby to encourage the exploration of abandoned mines. On the contrary, my purpose is to point out the many reasons to stay out of abandoned mines. Remember that 30 or more people will likely die in abandoned mine accidents across the country this year. If you insist on entering abandoned mines, one of those fatalities could be you.

So before succumbing to the temptation to peer into a deep, dark shaft or enter a portal to see what minerals can be collected from exposed veins, think first of the many waiting dangers. Remember, as the BLM says, the only real way to eliminate those risks is to "Stay Out and Stay Alive."

ROCK HOBBY PIONEERS

A Tribute to Ed and Verna Jones

Story by Barbara L. Miller

VERNA JONES PHOTO

Ed "Chicken" Jones uncovers a treasure in the desert east of Cisco, Utah.

There are many early pioneers in the rock, dinosaur bone, and petrified wood-hunting field. Two of the early rock-loving pioneers were Ed "Chicken" and Verna Jones of Grand Junction, Colorado. They enjoyed the hobby to the fullest and gave many great memories to other rockhounds by leading trips, helping to build the local clubhouse and auditorium, contributing to the club's annual show, selling their treasures at reasonable prices to fellow rock lovers, and, on many occasions, generously giving or donating pieces that would be treasured forever by the recipient.

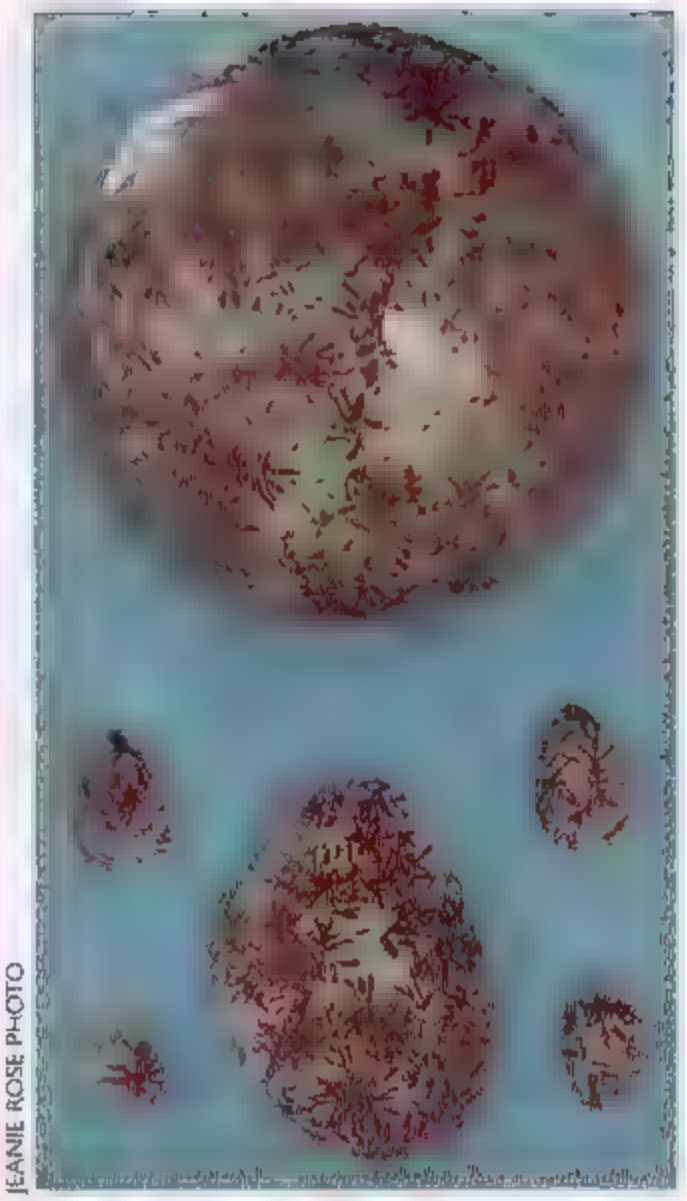
I and my husband, Keith, of Longmont, Colorado, had the good fortune of meeting the Joneses at the Big Sandy Rock Swap north of Rock Springs, Wyoming, over the July 4th weekend in 1996. Chicken entertained the evening potluck group with introductory or humorous stories.

We were interested to know the origin of Ed's nickname, Chicken. We learned that Ed and Verna had moved to Grand Junction, their favorite vacation getaway, in 1958, when they tired of farming almost 2,000 acres near Hugoton, Kansas, for 17 years. They opened a restaurant, which operated under several names. The most memorable was Finger Lickin' Chicken. The Joneses mounted a huge, yellow, fiberglass chicken with a red comb in the bed of their pickup and hung Finger Lickin' Chicken Restaurant advertisements on the doors. The customers and townsfolk identified the proud chicken display with Ed, and he has been known as Chicken Jones ever since.

In the early 1960s, the Joneses began hunting coprolite (petrified dinosaur dung) and dinosaur bone after customers showed them their finds. They asked where the pieces were found, and were told, "Out in the hills!" Chicken said that was quite a challenge, as there are hills in every direction. Luckily, they went for a drive west of Colorado National Monument at Black Ridge and, with beginner's luck, found coprolite and dinosaur bone. On another trip to the same area, Chicken and Verna found a large, petrified seed fern, Rexoxylon, which is an unusual find in our country; a knowledgeable person told us there were none in the United States, but Chicken's fossil proves that Rexoxylon existed in Colorado. Before Chicken cut the fern, we noticed it resembled a giant pineapple. Black Ridge is no longer open to rockhounds.

West and south of the Colorado National Monument and overlooking the confluence of the Colorado and Dolores rivers in Utah, Chicken and Verna found a new location for petrified Tempsky fern. We were pleased to be invited to accompany the Joneses and other local club members on this mid-September trip. Heading west at Glade Park Store, we drove the old Stagecoach Road from Grand Junction toward Moab, Utah. We saw fresh snow on the higher-elevation mountains as we traveled through very scenic coral-colored bluffs and mesas, with picturesque cattle ranches and bay meadow pastures. At the fern-hunting area, we could look down from the hill and see the Colorado and Dolores rivers below. Everyone found specimens of Tempsky Fern. The Grand Junction rock club has a map to this area among the field trip maps they issue to members.

Chicken was adamant about rockhounds respecting the land and would not tolerate those who did not. He came upon a younger and much taller man deliberately breaking up geyserite formations with his hammer. Chicken heatedly informed him to stop, saying his grandchildren would have enjoyed seeing these formations if he hadn't destroyed them! The man sheepishly hung his head and left. He knew he was in the wrong.



JEANIE ROSE PHOTO

The Joneses found snowflake jade in a quartz matrix north of the Graham Ranch in Wyoming.

Verna Jones enjoyed going rock and jade hunting. She would find treasures to transform into beautifully polished cabochons, using the lapidary skills she learned in a class in Mesa College in the late 1960s. She also learned silversmithing at the local rock club workshop after it was built and equipped. Verna made many sterling silver rings and pendants using her cabochons that family and friends love wearing today.

At one time, the Joneses had more than 300 spheres, the majority of which had been made by Chicken. He had many beautiful spheres, but one of our favorites was one made of Indian Paint Brush agate, or Castillejo. It was their new find in Yellow Cats Hidden Valley, south of Cisco, Utah. It has greenish gray background with rust-colored flowers. Chicken sadly reports that there was a limited supply of his new find. We are the proud owners of a small Indian Paint Brush sphere he made.

The Joneses delighted in going jade hunting in Wyoming. They left their RV at Mrs. Countryman's Sweetwater Station campground during each trip. One jade-hunting trip produced vivid memories they will never forget. They drove north from Sweetwater, turned east on the road that borders the Graham Ranch on the north, continued past the microwave tower to park, and began looking. Chicken had found a good chunk of Snowflake jade and was carrying it back to the pickup when he spotted another piece partially buried in the dirt. Bending over to dig it out with his rock hammer, he looked under the sagebrush in front of him. Two sets of angry eyes stared at him, attached to a pair of diamondback rattlesnakes! He yelled to Verna, "Rattlesnakes! I don't have anything to throw at them but this hunk of jade!" She yelled back, "Don't throw the jade, don't throw the jade!" During another trip to that area, Chicken found a chunk of quartz about 5 inches in diameter, which he cut at home. It is an unusual specimen, a pale green quartz matrix, with several apple green jade inclusions throughout the piece.

While they looked for jade north of Sweetwater, Verna had been grumbling that she had not found any when suddenly she dropped to the ground and yelled. The dirt began flying as she dug with her rock hammer. She dug out a partially buried large, olive-green jade "slick" that had been weather and wind polished during most of its existence. She was very proud of her find. The couple also found a very dark olive-green jade chunk with quartz crystal inclusions.

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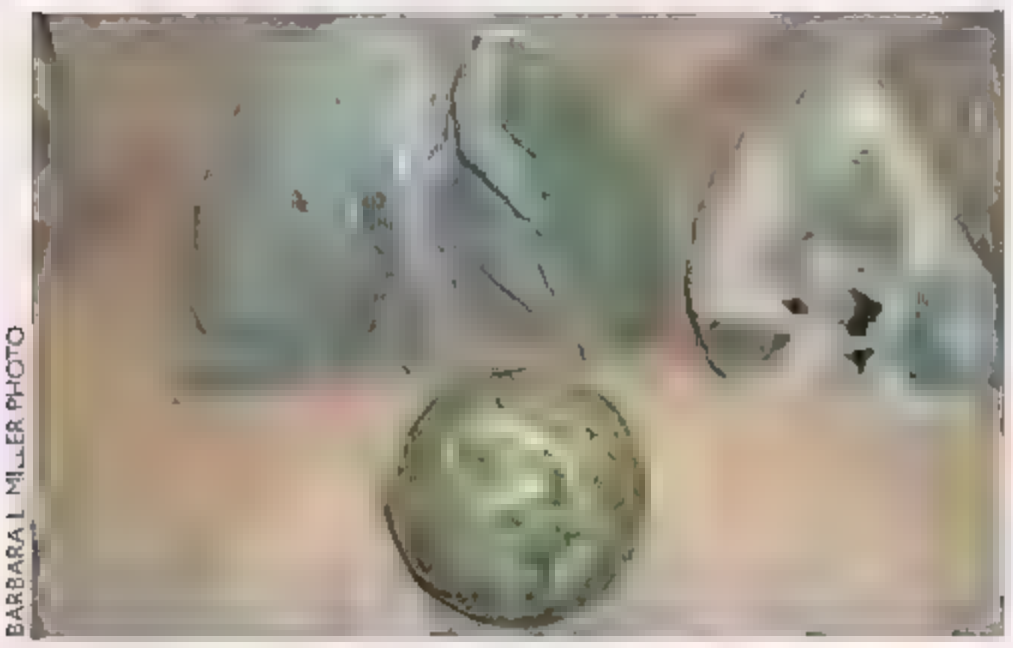
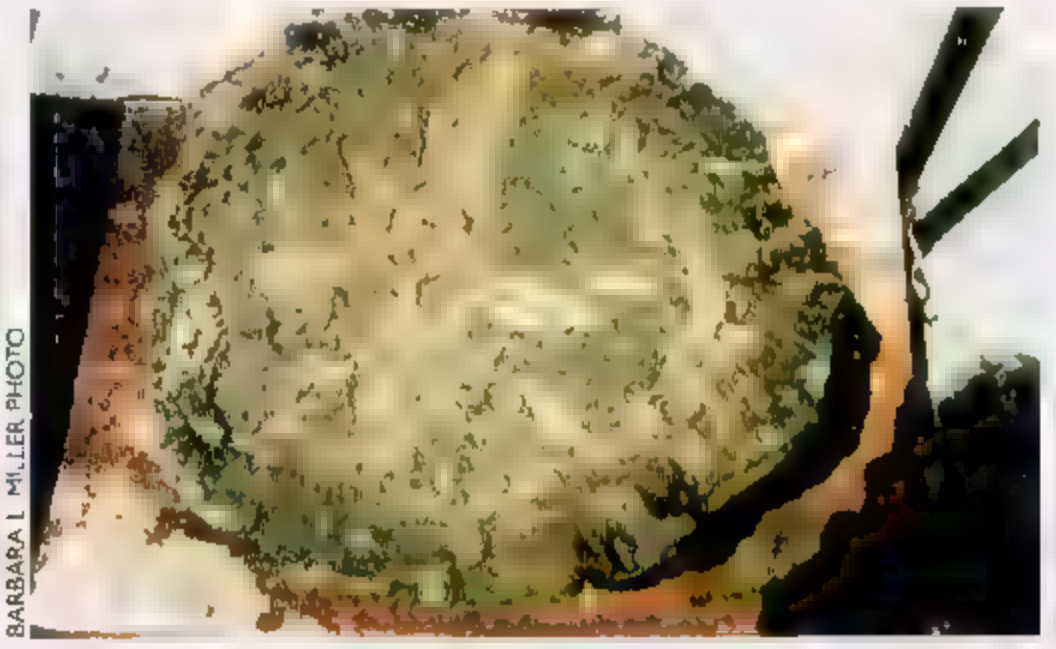


BARBARA L. MILLER PHOTO

Chicken and Verna found Indian Paint Brush agate in Yellow Cats Hidden Valley, Utah.



BARBARA L. MILLER PHOTO

Chicken found a round of unidentified petrified wood near Family Butte in San Rafael Swell, Utah.

Rock Hobby Pioneers *from page 65*

Hunting Blue Forest petrified wood east of the Fontinelle Lake and Dam, north of Green River, Wyoming, was another of the Joneses' favorite trips. They led more than 20 field trips from Grand Junction to the digging area, a 357-mile trip each way. Chicken's humor came to surface on the maps he made to guide rockhounds to hunting sites. On the Blue Forest map, he added to the instructions, "Take a large pick, shovel, broom and take your own bush!" (Those who have been hunting Blue Forest wood know that bushes are few and far between.) Chicken instructed those ready to find wood to shovel the sand and dirt down to the shale, then sweep the shale with an "old corn broom." If the shale buckled upward in a line, there was generally a petrified log underneath. Picking carefully through the shale would uncover the blue chalcedony-coated petrified wood.

On these field trips, folks generally found good specimens and enjoyed listening to Chicken's stories around the evening campfire. He told them about raising broom corn and how to strip it before harvesting for the straws to appear. He said corn brooms are the very best to buy. One example of his jokes: "If you go hiking in the mountains, be sure to have a fat man between you and the bear."

Beaver Rim, north and west of Sweetwater, Wyoming, is a good hunting area. The Joneses found Pandanas, better known by most as Petrified Transition Palm. We have several nice chunks from their find that we treasure highly.

Utah is a state that rockhounds frequent, as there are good hunting areas. Floy Wash has many kinds of collectibles. Chicken and Verna found septarian nodules, aragonite crystal clusters, rock dishes, and various agates.

Ed "Chicken" and Verna Jones have been active and generous members of the Grand Junction, Colorado, rock club.

Pigeon Blood agate had been located earlier. On his map, Chicken marked the sand washes that required four-wheel-drive vehicles to cross. Many rockhounds dry camp in their RVs near the corral, giving them close access to the various sites. We hunted in Floy Wash while in the area attending the Moab, Utah, rock show, which is held the second weekend in October. We found several kinds of rock using the map Chicken had provided.

From Interstate 70 exit 147 in Utah, we drove south about five miles to join Chicken, Verna, and other rockhounds from their local club. The Joneses led everyone almost two miles, meandering generally west, to the wart agate collecting site. Occasionally, grape agates are found there, they have larger botryoidal extrusions than wart agate. Chicken and Verna had been going there for years and knew the best hunting sites. We found many small pieces of wart agate and a few grape agates. It is fun to see our great-grandchildren's or young neighbors' expressions and happy reactions when we give them one and tell them it is a wart agate. They are aptly named, a pale red agate covered with tiny warts or grapes.

The San Rafael Swell is a neat rockhunting area that the Joneses have visited many times. From I-70 exit 129 in Utah, drive south. Do *not* take the Goblin Valley State Park road (though it is a great place to see if you have the time), but continue south and then west, taking the right forks. At the last fork, drive north about a quarter-mile to the camping area. Hike or use an ATV to get to the east side of Family Butte and look for various kinds of petrified wood. The Joneses found a full round about 18 inches across that had a cream-colored, five-pointed star in the center. It has never been identified.

Schilderia rounds that were a brownish color with the wood grain spraying outward from the center were another of their finds. It was an exciting day when they found black petrified wood with smoky quartz crystals embedded in it. They were spectacular specimens. Chicken found very unusual petrified wood pieces with tiger-shaped inclusions. He had them identified and learned that the inclusions were pecky rot fungus. The Grand Junction club has a good map to this area for members. While you are near the Family Butte, take the left fork and drive west to see Red Canyon. There is an unforgettable view of an immense canyon from the rim.

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ROCKHOUNDS, *by Chicken Jones*

Life in our little house ain't what it used to be
  Since Ma went back to school and took up lapidary
Now, rocks around our house abound, you'll find them everywhere!
  On the breakfast table, in the kitchen sink and my big old easy-chair.
They're in every corner, on every shelf and all the window sills.
  In our medicine chest, I'm sure you'll find rocks instead of pills!
We don't go fishin' anymore we just go huntin' rocks.
  She drags me up and down those hills till my shoes eat up my socks.
Now, we've brung home a million tons mostly junk and crud
  But it don't seem to bother her, I guess rocks are in her blood!
This thing is getting out of hand it really has me thinking.
  I don't know what we're gonna do—our house has started sinking!

Rock Hobby Pioneers *from page 67*

The Joneses liked to go to Yellow Cat, southwest of I-70 exit 202, near Cisco, Utah, to find rosy red agate pseudomorphs after barite and petrified wood (*Gem Trails of Utah* and the Grand Junction club have maps to this location.) They found a unique, small log that, whencut, had wood chips inside. It is amazing what one finds inside petrified wood and stones. As I tell my beginning lapidary students, when you cut a rock you are the first person to see what has been inside it for millions of years.

Chicken helped his daughter, Jeanie Rose, set this sea turtle mosaic, featuring jade, coprolite, and dinosaur bone, in her dining room floor

When the Joneses found new specimen areas, Chicken would make a map so they could bring rock friends back to the site. All rockhounds love to hunt for new material. He made 11 maps representing rock-hunting areas in Colorado, Utah, Wyoming, Arizona, and Oregon. He donated these maps to the Grand Junction club several years ago.

The Joneses joined the Grand Junction Gem & Mineral Club when they began hunting in the early 1960s. At that time, the club met in the REA building on the east end of Grand Avenue. In 1970, a member sold the club a lot, and it began building a clubhouse. Chicken and other members did the construction work. They installed lapidary machines, enabling them to hold classes. They had their Christmas party in the new clubhouse. As the membership grew, they didn't have room enough to hold meetings. Chicken suggested twice that they should build an auditorium, but no action was taken. The third time, they said, "OK, you will be the chairman of the appointed building committee!"

In 1976, the auditorium was built, and although it was not finished, their Christmas party was held in it. The club then bought a second lot to solve its parking problems. Chicken said very few clubs have their own building with equipment to hold lapidary, silversmithing, enam making, and other classes for their members. Several years ago, the club added another building to use as a workshop. The Joneses have given much rock to the club to sell to raise money. Just recently, they donated bone specimens to put in the club's museum display cases.

The club sponsors an annual gem and mineral show at the Convention Center in downtown Grand Junction during the second weekend in May. Chicken and Verna have helped with the show and have placed their specimens in one of the 24 exhibit cases for rock lovers to view. Each year, their display had a different theme or subject, including dinosaur bone, Blue Forest petrified wood, spheres made by Chicken, Verna's cabochons set in her handmade silver mountings, and various kinds of petrified wood. When the Joneses were still displaying at the show, their specimens were always of top quality and we loved seeing them.

Chicken and Verna sold much of the wood, rock and jade they found at various shows and at Quartzsite, Arizona. While going to Quartzsite, they met fellow rock lovers from home. They camped and rockhounded together in "Grand Junction South" in January and February. The Joneses stay close to home these days for health reasons. Several of their children are learning lapidary and use many of their parents' treasures. Their daughter, Jeanie Rose, created a 4'-foot by 3'-foot mosaic sea turtle that is the focal point of her dining room floor. Coprolite, dinosaur bone, jade and blue forest petrified wood were used in the lifelike sea turtle. She says, "Thanks to the expertise and equipment of Chicken Jones."

On May 31, 2005, Chicken and Verna Jones celebrated their 64th anniversary. With a twinkle in his eyes, Chicken says, "We have had 57 years of wedded bliss, which ain't bad out of 64, is it?" We noticed that he never explains those seven years! Verna, in her quiet nature, just smiles. They sadly remark that they can no longer go on the rock hunting trips they enjoyed so much.

These two pioneers have been instrumental in showing the way to new generations of rock lovers by helping to generate interest in the many aspects of the hobby, whether going on rock hunting trips, participating in the local club, displaying newly found treasures at local shows, or providing numerous specimens for fellow rock lovers. For all of this and more, we thank you Chicken and Verna.

MINERALS OF THE LANGESUNDFJORD

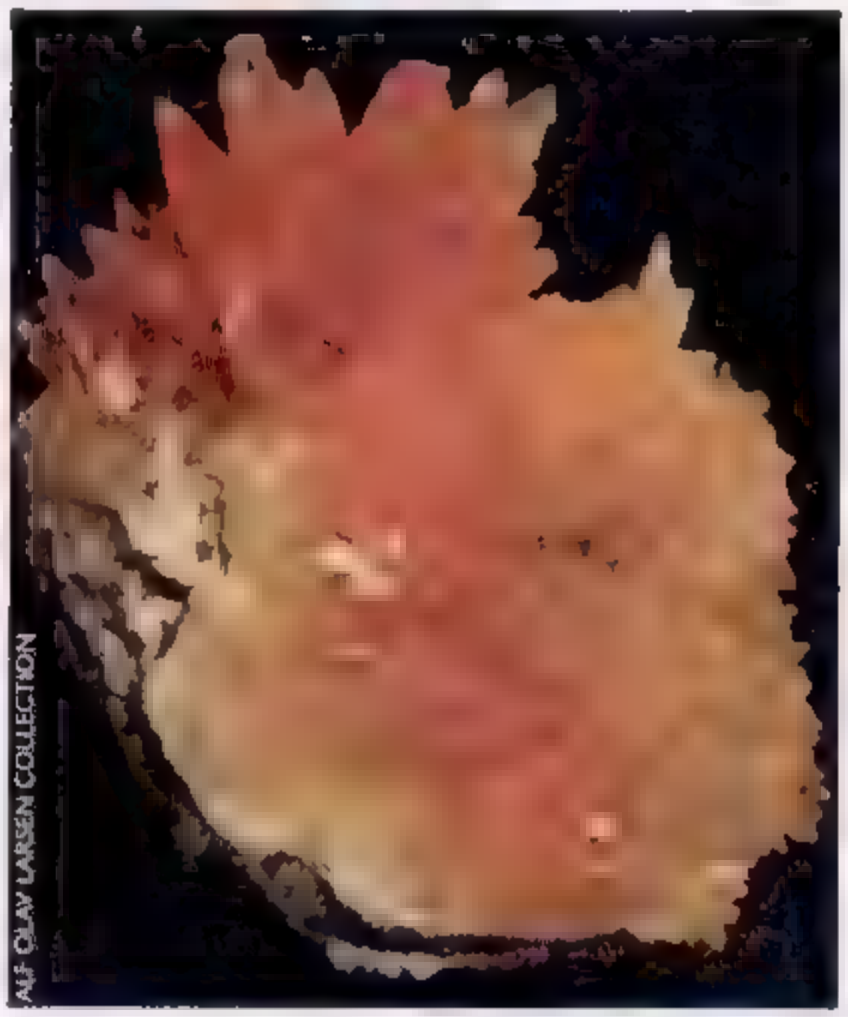
Scientists and Collectors Seek Exotic Species in Southern Norway

Story and Photos by Kiera Tara O'Brien

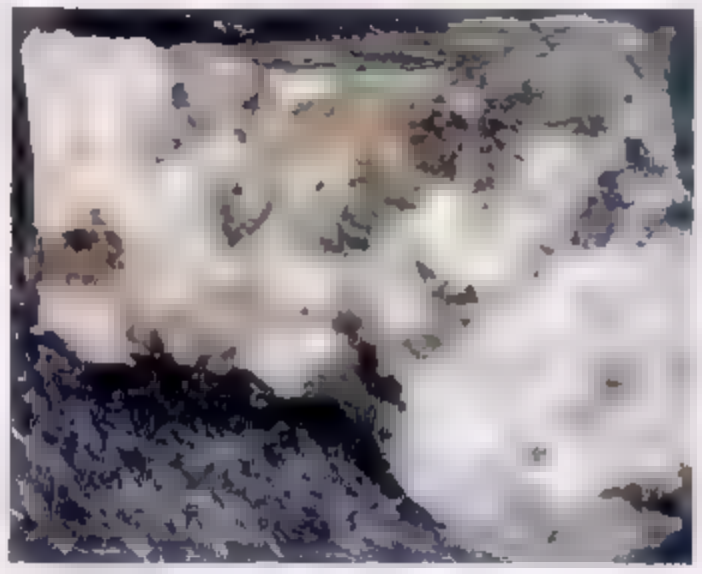
When the young pastor of Brevik, Hans Morten Thrane Esmark, rowed out into the sea around Norway's Langesundfjord for some duck hunting, he never guessed that he was about to discover a new mineral and element on the rocky shores of Løvøya Island. It was early in 1829 when Esmark spotted a jet-black mineral sparkling in the pegmatite boulders dotting the rocky shore.

An avid student of chemistry, mineralogy, and potato diseases, Esmark collected a few specimens of the mineral and sent the pieces off to Stockholm, Sweden, for examination by the famed chemist Jons Jakob Berzelius. Berzelius soon discovered the element thorium inside the chemical structure of the curious mineral. Berzelius, the humble scientist, refused the honor of having the new mineral named after him, so Esmark eventually christened the new specimen "thorite," after the hammer-wielding Norse god of thunder, Thor. After Auer von Welbach invented the incandescent-mantle lighting device toward the end of the 19th century using refractory thorium oxide, all the thorite from the Langesundfjord was quickly snatched up by small-scale mining operations. The frenzy continued until the invention of the light bulb rendered this element obsolete in the field of artificial illumination.

This remarkable tale of discovery is just one of many attributed to the Langesundfjord (and Tvedalen) region located in the state of Vestfold in southern Norway, about 130 kilometers from the capital, Oslo. Mineralogist and resident expert on the Langesundfjord Alf Olav Larsen is just one of many Norwegian collectors and scientists enthralled by the unique and rare specimens that have been found in this beautiful, island-dotted, coastal inlet. "I really think this area deserves more attention," he says. "With nearly 200 known species and nearly 25 types of minerals, this district can match several of the more famous mineral localities."



Brightly colored calcite from the Dallen Mine at Brevik is an exceptional variety of one of the more classic specimens found in this region.



The extremely rare mineral chlavennite—this microscopic form is from the quarry at Langangen—was discovered in this region and in Italy at the same time

Indeed, the Langesundfjord is one of Norway's most fruitful areas for geological study and the discovery of new mineral species. Many of the specimens found here occur in only a few areas on the planet and are relatively rare and exotic finds. The Langesundfjord is located on the edge of a large alkaline complex known as the Larvik Plutonic Complex, which stretches down the Oslo-region rift valley and reaches into the Saga quarry region and the neighboring Telemark county. The geological history of this region features an array of plutonic and volcanic rocks dating to the Cambrian, Ordovician, Silurian, Permian, and late Carboniferous eras, aging them from around 280 million to 230 million years. The Oslo rift valley started to form nearly 300 million years ago when enormous stress on the continental plate caused certain parts of the land to fracture and sink, while other sections eroded away over time, exposing older rock levels at the surface. During the late Carboniferous and Permian eras, the whole area was characterized by extensive magmatic activity and was bordered by lava flows running from the north.

Found in the southern part of the Oslo rift valley in an agpaitic pegmatite complex, the Langesundfjord region is sur-

rounded by Pre-Cambrian sediments on its outskirts. The mainland is comprised mostly of younger Cambrian- and Silurian-era rocks. It is dominated by larvikite rocks, with frequent penetration by glimmer-syenites (comprised of mica) and nepheline syenites. The islands of the Langesundfjord are even younger than the mainland, composed of Permian remains, and are characterized by irregular syenite pegmatites. Låven Island, for example, is really just one giant pegmatite sticking out of the water. Agpaitic nepheline syenite pegmatites comprise a group of rare rocks that formed in a specific geochemical process, in which silicate elements are enriched in alkali metals, producing some unusual (and very rare) mineral species. The name "agpaitic" was originally given to the rocks of the Ilimaussaq complex in southern Greenland.

Larvikite, named after the nearby town of Larvik, is a medium to coarse-grained rock that is extensively used in architectural projects. Originally, small-scale rock mining in the area began sometime between the late 1700s and early 1800s, with local farmers gathering materials for their personal constructions. Only around the late 1880s did the area start to be quarried for commercial purposes, producing decorative pieces for architects, such as that used in the façade of the United Nations building in New York City. Currently, around 20 larvikite quarries are operating in the area, with a huge number of abandoned quarries and rock dumps littering the region. Mineral and rock collecting is possible in some of these quarries, as well as at some nearby pegmatite outcrops in the surrounding forest. This area largely consists of syenite pegmatites that are anywhere between 10 and 30 centimeters thick; hundreds of different mineral species have been found in the numerous dikes.

The syenite pegmatite dikes in the Langesundfjord and Tvedalen regions have at least one, but often two, identifiable phases of geological development: the primary, or "magmatic," phase and a secondary, or "hydrothermal," phase. The secondary phase typically results in an extensive zeolitization of the existing magmatic minerals, with crystallization of certain remaining elements in the low temperatures. Many of the rare mineral species found in the region develop in the unique mix of chemical elements that exists during this stage of the pegmatite's evolution.

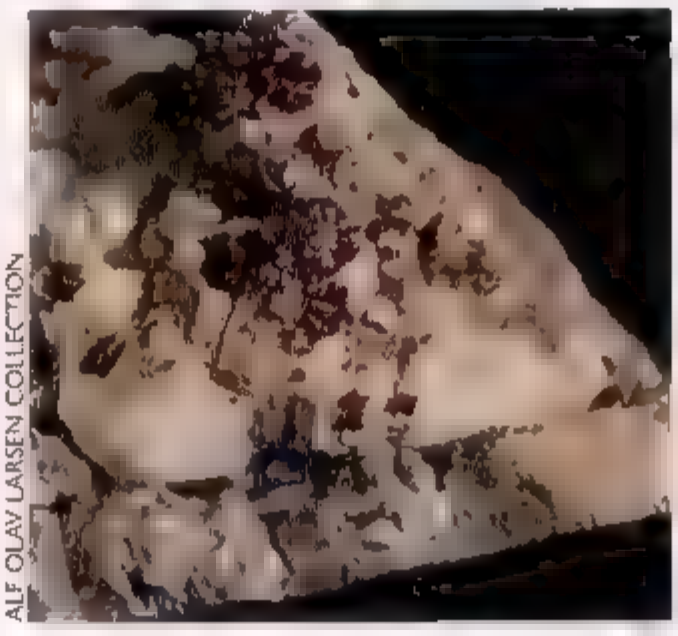
At many of the larvikite quarries and a number of other famous localities, special permission is required for any collecting beyond picking up loose pieces; in some spots, namely the islands of Låven and Skudesundskjaer, collecting is strictly prohibited by law. These restrictions have been put in place to preserve the areas from over-collecting and to ensure the future of this scientifically exciting region.

ALF OLAV LARSEN COLLECTION

Delicate pale green diaspor crystals grow inside miniature to small cavities in the many pegmatites of this region

Local mineralogical expert Larsen and a group of fervent geologists and professional collectors specializing in the exotic and unusual minerals of the Langesundfjord are dedicated to uncovering and investigating the scientific mysteries of the region. Historically, the islands in the Langesundfjord were key sites for mineral prospecting, particularly in the 1800s. Like the mainland, the islands are extremely rich in mineral-bearing pegmatites. The rush for Esmark's thorite took place largely on a number of islands in the fjord, and many of these sites bear the marks of extensive blasting in the hunt for minerals. Skudesundskjaer Island, for example, a small, rocky hump in the fjord, was heavily blasted around 150 years ago.

Quarrying activities in the area have been a major player in exposing mineral pockets. A hardy mineralogist since he first became fascinated with geology as a child, Larsen escorted me on a visit to a huge quarry at Langangen. The weekend before had been a big event for those interested in the region. At Tutten Quarry, quarrying activities opened up huge, vuggy pegmatites and revealed pockets of mostly natrolite and analcime crystals.



ALF OLAV LARSEN COLLECTION

Manganese rich, reddish-brown helvite occurs as small, dispersed tetrahedral shapes on a rocky matrix in situ with analcime crystals

At Langangen, Larsen and a fellow enthusiast named Peter were on the hunt for new specimens of microminerals in the toppled quarry blocks. The clean-cut faces of the quarry walls were riddled with small to large vugs, or pockets, displaying cavities of mineralogical delights, particularly some beautiful specimens of clear to grayish, spiky natrolite. Larsen pointed out some exquisite, but tiny, minerals found in the quarry; these small occurrences may not be spectacular in size, but they are some of the rarest minerals on Earth, found elsewhere only in alkaline deposits at certain localities in Canada, southern Greenland, and on the Kola Peninsula in Russia.

The discovery of minerals in the Langesundfjord region first took flight in 1801 with the identification of feldspars in the area. One common feldspar known from the area is the silicate albite, common as a collector specimen, but also regularly used as ornamental stone. The last of the feldspars to crystallize, albite is typically white, but its tabular and platy crystal shapes can have slight shadings of blue, yellow or orange and are often associated with muscovite and quartz.

Another interesting silicate discovered in the Langesundfjord was leucophanite, a rare beryllium silicate. This was first found during the mining rush of the 1800s and was named after its white coloring. It is sometimes also found with yellow or greenish tints. It often appears in rectangular or cube-shaped crystals with some aggregate rosettes, and is associated with other rare minerals, such as aegirine, albite, natrolite, astrophyllite, fluorite, analcime, epididymite, and microcline.

The Norwegian geologist Waldemar Christopher Brøgger (1851-1940) was a major player in identifying and describing the mineralogical composition of this region. In a major book on the area (available only in Norwegian, unfortunately), Brøgger provided a description and discussion of almost all the mineral-producing pegmatites, cataloging around 75 minerals for the area. The last discovery of the "old age" of Langesundfjord mineralogy occurred in 1890. It wasn't until gadolinite was found in 1978 that the "new age" of discoveries commenced. Enthusiastic amateur geologists and chemists were largely to thank for this resurgence, although advances in modern technology certainly played a major role.

continued on next page

Minerals of the Langesundfjord *from page 73*

Dedicated mineralogists Alf Olav and Peter are out and about at least once a week in their hunt for new specimens. At this quarry they are searching for new micro minerals.

One recent discovery in the Langesundfjord was the bright-orange mineral chiavennite in 1983. Occurring in four different localities, chiavennite appears as reddish-orange spherulites, sometimes with associated minerals such as hamburgite, aegirine, natrolite, calcite, and chlorite. Chiavennite was also discovered at a site in Italy. Both the Italians and Norwegians presented their findings to the chief mineralogical council for confirmation in the same year. In the end, the Italians got to name the new specimen. However, in 1997, the Norwegians were given a fresh opportunity at the name game. Another new mineral was found overgrown by an occurrence of chiavennite in the Veyia quarry. Characterized by cream-white to pale-beige spherulites up to 3 millimeters wide, this specimen was named tvedalite after Tvedalen, the area in which it was discovered.

The larvikite quarries in the Tvedalen area have proved to be a major source of mainland pegmatites. The most common minerals found in these quarries are microcline, ferro-edenite, magnetite, nepheline, and biotite. From the Saga I larvikite quarry, which operated between 1970 and 1994, a huge syenite pegmatite was revealed and has proved to be a "gold mine." This is probably the largest dike extensively uncovered by blasting in this region. Nearly 40 percent of all minerals found in the Oslo region came from Saga I — more than 70 different species! Huge versions of some locally common minerals were extracted from this pegmatite: biotite up to 70 kilograms, leucophanite and thorite weighing several kilos, and nepheline weighing a few hundred kilos, for example. A number of extremely rare minerals were also discovered, including berborite, bromellite and ephesite. Bromellite occurs as white to creamy platy crystals in natrolite-filled vugs, while berborite appears in clear, almost transparent, tiny crystals set in a rocky matrix.

The mineral species found in the southwestern side of the pegmatite, an area known as Sagaåsen, include astrophyllite, tadzhikite, eudidymite, epididymite, gonyerite, mosandrite, and yellow to orange zirsilites of the eudialyte group. Also found in the Saga quarries are manganese-rich helvite specimens, this bright yellow specimen received its name from "helios," the Greek word for the sun. Brown to reddish-brown helvite was found in the nearby Hakestad larvikite quarry in 2000. The specimens were formed in tetrahedral shapes, often in close association with analcime.

A pale-green version of helvite had earlier been identified from the famous locality of Bratthagen, which consisted of several nepheline syenite pegmatites in which around 60 different mineral species have been found, including chrysoberyl, barylite, lorenzenite, and loparite. Lorenzite is a rare mineral found only in alkaline localities in lustrous brown and yellow-brown varieties. Chrysoberyl occurs in three varities: a yellowish-green gemstone, a cat's eye formation, and the rare metamorphosing gemstone known as alexandrite. Barylite is bluish white immature specimen, while loparite appears in dark, cubic crystals. Bratthagen has been protected by national law since the mid-1980s in order to preserve the area from complete destruction.

Another famous, but relatively small, quarry in the Tvedalen region is Veyia, the type locality for tvedalite. This area contains several pegmatite dikes rich in chiavennite, natrolite and gonnardite crystals. Gonnardite is a vitreous, white mineral made up of spherical, fibrous crystals.

The pegmatite dikes at the Ula locality in Tvedalen comprise another small, but impressive, deposit. They have been well known since the 1880s as a source of beautifully schillerized feldspar, minute platy or rod-shaped enclosures reflect light from their numerous tiny surfaces to give the feldspar a shimmering appearance. The main mineral

found here is a grayish cryptoperthite that shows pale blue to greenish-yellow schiller. One of the pegmatite dikes at this site is a famous moonstone spot, which has produced rather gemmy specimens.

Another exotic mineral that attracts collectors for its lovely coloring, bright luster, and well-formed crystals is fluorapophyllite. This is the most abundant and colorful variety of what is usually just labeled apophyllite in many collectors' cases. Excellent greenish-yellow examples of this mineral, in association with natrolite formations, have been found at the Ireschow and Saga Pearl quarries in the eastern half of the Tvedalen area. This area is also known for helvite, epididymite, and yellow and orange chiavennite specimens.

The final larvikite quarry of mention at the moment is Tuften, formerly known as Svensken. Interesting finds have included microline crystals (often known as the semiprecious stones amazonite and perthite), yellowish to white hambergite in situ with large aegirine crystals, clear natrolite intergrown with fluorapophyllite, and thomsonite, a rare zeolite, found in thin fanned flakes.

Off the coast of the mainland, the islands of this fjord have historically been the prime focus of mineral collecting. Many of them are now protected from collecting due to the diversity of the minerals found on them and their specific scientific importance.

Perhaps the best-known island locality is Låven, translated "the barn," named for its tall, long, rounded shape. Several spots on the island bear the scars of 19th century collecting using explosives. Låven consists of a thick syenite pegmatite overlaying a foundation of basaltic rock. This is the historic source of the rare earth mineral, mosandrite, but around 50 different minerals have been found on this island. It is the type locality for six species: catapleiite, aegirine, tritomite, låvenite, mosandrite, and leucophanite. Also found in Canada, Greenland, Brazil and Russia, låvenite is a rare mineral that was named for the island after its discovery in 1885. A yellow to brownish color, small specimens have aggregates around 5 millimeters long. The mineral is usually found in situ with aegirine, analcime, astrophyllite, biotite, microline, and zircon.

Neighboring Stokkøya island is also comprised of a basaltic core covered by a large pegmatite. This pegmatite, centered in the southern half of the island, has yielded mainly large individual specimens of microcline, biotite, nepheline, aegirine, and magnetite. Some accessory minerals include mosandrite, leucophanite, fluorite, albite, chevkinite, and zircon. A second pegmatite sitting near the top of the island's highest peak was known as a source of black garnet in the mid-1800s, but became a prime interest of the invading Germans as a source of zircon (and the element zirconium) during World War II. Larsen discusses the history of zircon prospecting on the island in a 1996 paper for *Nevjar*: blasting at the site in the autumn of 1942 resulting in 2.5 tons of zircon-rich pegmatite being extracted from the island, effectively destroying this locality.

A final interesting locality in the fjord is the island of Skutesundskjær, which is actually two neighboring islets that are connected at low tide. Grayish microcline is the main mineral found on this island, but it has also been the main locality for wöhlerite, found in excellent crystals several centimeters long, and for rosenbuschite, an extremely rare mineral occurring in yellow to beige crystals.

The last discovery of a new mineral, specifically a micromineral, in the Langesundfjord happened just a few years ago. Named grenmarite, this mineral was found in a pegmatite at the eastern side of the island Vesle Arøya, occurring with yellowish-brown, flattened crystals up to 1 centimeter in length.

It is pretty clear that this alkaline region is a bustling center of mineralogical study and discovery with a diverse assemblage of silicate and rare earth minerals. Thanks to the dedicated work of amateurs and some professionals, 180 different species of minerals have now been accounted for in the region since the resurgence of the 1970s, a huge leap from the 75 described by Brøgger in the 1800s!

The curious and often delicate minerals produced in this area have a captivating effect on both scientists and collectors for their beauty and their uniqueness. The rocks from this region are enriched in alkali metals and unusual concentrations of exotic elements, such as beryllium, producing equally exotic and rather rare minerals, specimens that can add character to and spice up any collection. New minerals may be discovered at any time in the many famous localities of this region, where blasting for holiday homes and quarrying activities is constantly turning up new pockets of goodies. Who knows what may come next?

Rock Science

by Steve Voynick

Diamonds in the Sky

Diamonds come in many colors, and one of the most interesting is black. Although lacking both eye-catching beauty and gemstone value, black diamonds have been getting a lot of scientific scrutiny because their origin is the most mysterious of all diamonds.

Black diamonds were discovered in 1840 by Brazilian placer miners, who named them "carbonados," after the Portuguese word for "burned" or "carbonized," because of their dark color. Like the more familiar "clear" diamonds used as gem and industrial stones, carbonados consist of carbon, are extremely hard, and crystallize in the cubic system.

But in other ways, carbonados are quite different. Unlike clear diamonds, which are single crystals, carbonado consists of porous aggregates of millions of tiny, randomly arranged crystals. Clear diamonds occur in many nations worldwide, but carbonados only occur in two: Brazil and the Central African Republic. Another difference is that carbonados have only been recovered from placer deposits, and never from the kimberlite diatremes that provide most of the world's diamonds.

Carbonados are so rare that only some 2.5 metric tons have been mined in the past 165 years—very little compared with the 20 metric tons of clear diamonds that are now mined worldwide each year. The largest diamond of any type ever found was a carbonado from Brazil. Named Sergio, the celebrated stone weighed 3,167 carats, or about 22 ounces.

Carbonados make superb industrial abrasives because their multidirectional crystal arrangement provides far more cutting edges than the structure of clear diamonds. In the 1860s, carbonado was used in rock-drill bits used during the construction of the Suez Canal. Later, French cabinetmakers made it their standard abrasive for shaping and smoothing fine hardwoods.

Initially, scientists believed that carbonados formed just like clear diamonds, deep in the Earth's mantle where extreme heat and pressure transformed carbon into crystalline diamond. But no one could explain why carbonado occurred only in placers. Then, in the 1970s, researchers learned that the ratios of carbon isotopes and the type of inclusions in carbonado did not match those of clear diamonds, thus indicating something other than a mantle origin.

Carbonados are obviously quite old and have been found in extremely ancient placer deposits. In 1985, their origin was radiometrically dated to 4 billion years ago, a time when giant meteors regularly battered Earth's surface. Some researchers suggested that carbonado could have formed on Earth in the cataclysmic heat and pressures generated by meteoric impact.

Finally, in 1996, geologist Stephen Haggarty of the University of Massachusetts at Amherst proposed a truly innovative theory. According to Haggarty, carbonado did not originate on Earth at all. Instead, it came from dying stars, specifically exploding red giants (large stars with relatively low surface temperatures), where intense shockwaves crushed carbon into aggregations of crystalline diamonds and sent them hurtling into deep space. Eons later, our sun's gravity drew some of this material into our solar system, where it fell to Earth.

Critics immediately attacked Haggarty's theory, pointing out that any form of unprotected carbon would not survive the oxidation of atmospheric entry. Proponents countered that, 4 billion years ago, our atmosphere had little, if any, oxygen, meaning that carbonado could have reached Earth's surface.

Additional evidence now supports Haggarty's theory. In-depth, comparative analysis of carbonado from Brazil and the Central African Republic clearly indicates common origin. If carbonado did indeed originate in space, its fall to Earth could have occurred when South America and Africa were joined together as a single continent that later separated by tectonic plate movement. A single, massive fall could therefore explain the origin of carbonado in both Brazil and the Central African Republic.

Whether or not future research confirms or refutes this theory, the origin of diamonds will continue to fascinate us. While that of clear diamonds is a story of temperature and pressure within the Earth's mantle, the origin of carbonado may prove to be a tale of diamonds in the sky.

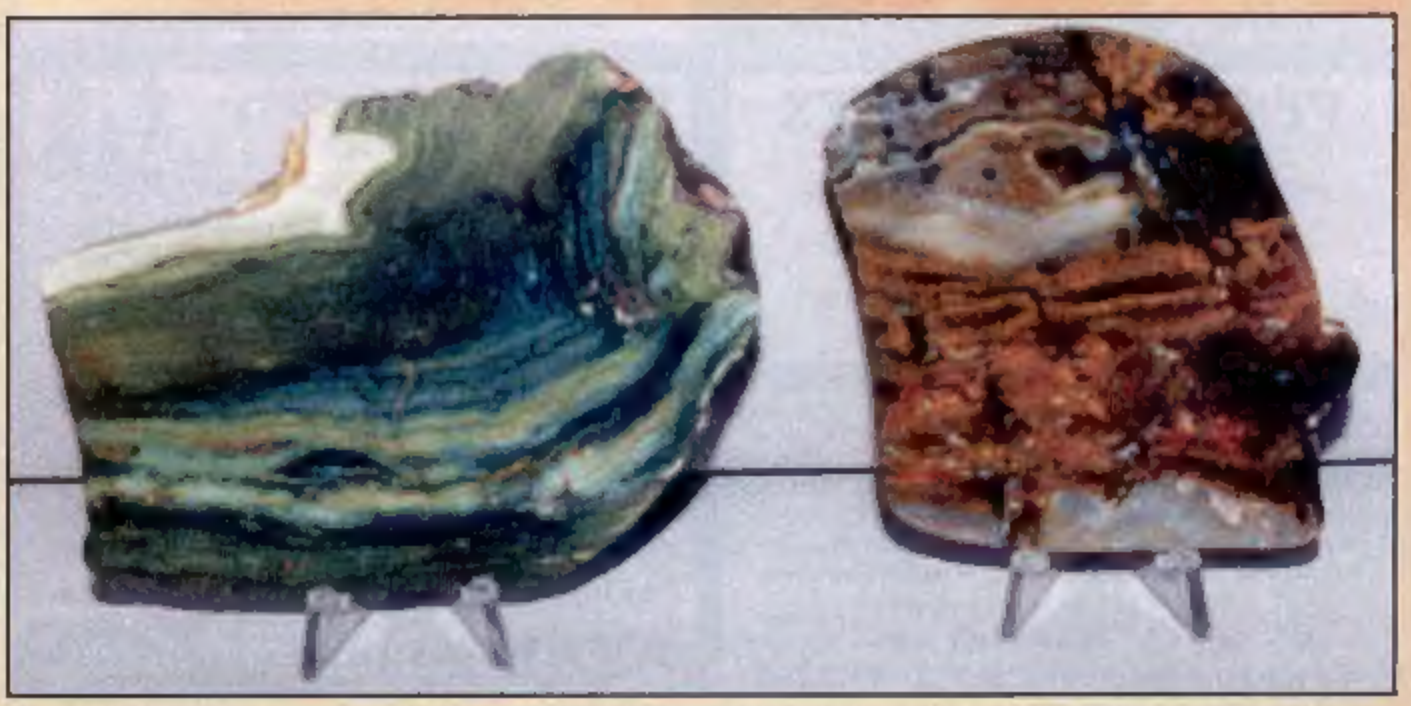
FIELD TRIP

The Minerals of McDermit

Agate and Petrified Wood on the Nevada/Oregon Border

Story and Photos by Milo J. Breite

Several of us stood high on the edge of the Columbia Plateau gazing over the McDermit collecting area and beyond. We had spent the three previous days, and would spend two more, collecting rock and petrified wood specimens in the vastness below. For now, it was fun to reminisce and point at specific locations in the distance. McDermit, a favorite spot and one well known to rockhounds for about 30 years, had lived up to its reputation. My wife, Dana, and I were part of a group of about 20. Everyone was happy with the quality and variety of the material they had found.



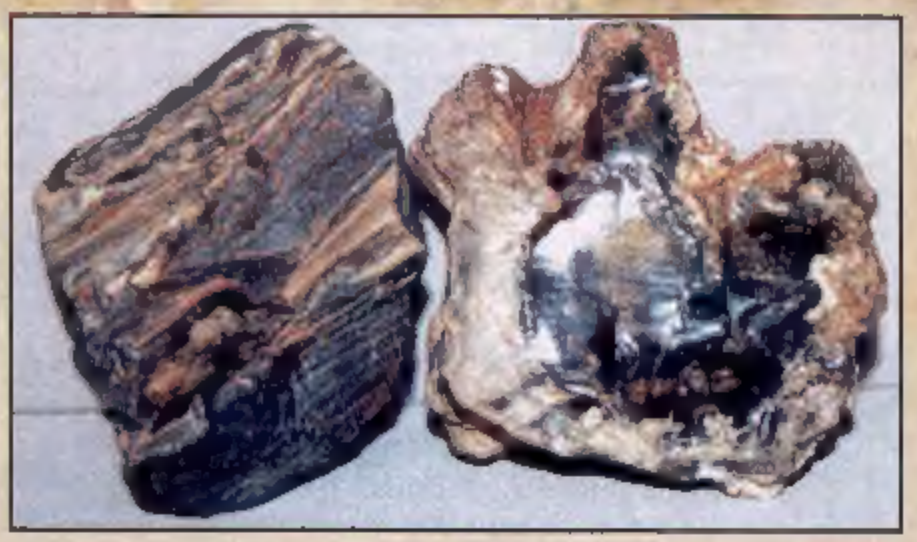
Much of the Cary Green jasper is pitted, but careful searching yields solid pieces suitable for lapidary work.

Dana and I had the privilege of being invited on a field excursion sponsored by the Rogue Gem & Geology Club, based in Grants Pass, Oregon. Our longtime friends Roy and Terry Lichtenstein organized the trip and were great leaders. We met a lot of nice folks.

The remote and friendly town of McDermit is geographically located on the border of Nevada and Oregon, about 64 miles north of Winnemucca on U.S. Highway 95. Geophysically, it is part of a large caldera at the boundary of the Great Basin and the Columbia Plateau. For rockhounds, McDermit offers a variety of material in a relatively compact area. Four-wheel-drive and high-clearance vehicles are handy, but not essential. During the week we were

there, we collected jasper, rhyolite, agate, petrified wood, and thunder eggs.

Although the McDermit region is well documented, the collecting areas are extensive, making it easy to still find good material, and the geologic history leads me to believe that there are still concentrations yet to be found. We stopped at many sites, some of which are not even noted as collecting locations on any of the available maps. These spots also yielded good material, though not in the abundance of the mapped areas.



These dark, fist-size pieces of petrified wood are a good example of the fine materials available to the collector at McDermit.

While McDermit is known to have a wide variety of collectible material, the many heaps of dirt scattered about the area rockhounds call "Airport" provide silent testimony to the perseverance of man in his quest for that special piece of petrified wood. From the number of holes in the vicinity, it is clear that Airport has, and may still, albeit grudgingly, rewarded the dedicated collector with fine specimens of petrified wood. The recent excavations I saw penetrated about 12 feet of overburden to get to the ash layer in which the wood is preserved. There are no guarantees once you get there. Two of our group dug for a full day and came up empty.

This fact should not cause any worry. The ash layer crops up at various locations and at different elevations throughout the hills and depressions leading up to the Trout Mountains and Disaster Peak. While wandering around one of the pits at Airport, I found a piece of petrified wood about 8 inches long and 1 inch in diameter. It is primarily blond with a few dark-brown streaks along its sides and is covered in fine grain detail. All in all, it is a good piece, and even though it was left behind or lost in the dirt, it explains why some people are dedicated enough to dig for hours and even days in their search for larger specimens.

Our convoy continued past Airport and, 11.4 miles from McDermit, made a right turn at the road junction that marks the beginning of a large loop through the collecting region. At 0.2 mile from the junction, we came to a small campsite and crossed Cottonwood Creek. Three miles into the loop, we passed a large, conspicuous knoll on the right. Roy calls this hill "Mount McDermit." Its surface is pockmarked with holes and, looking from the west, it stands out as a white knob overlooking the basin miles below. We stopped here several days later. There is no doubt this area has been thoroughly worked over for many years. The material that remains is highly fractured opal that does not exhibit any wood detail. I gave up on the hill and its slopes and hiked to the wash at its base. In the short time we were there, I found three fine specimens of petrified wood. While good material is not plentiful, "Mount McDermit" is another example that the McDermit collecting zone still has nice material, even in overworked, easily accessible places.

We continued past "Mount McDermit" another 1.4 miles, arriving at a road to the right marked by a conspicuous T-post opposite the turn. This road leads to a large, spread-out collecting zone. A short distance down the road, you will begin to see pieces of petrified wood and will actually drive over some. In addition to the petrified wood, which ranges from bogwood to opalized wood to finely detailed, highly agatized wood, there is common opal in a variety of hues, colorful "carnival" agate, and some purple agate. Much of the opalized wood is fractured; however, careful searching produced good display pieces in various shades and combinations of black, white and green. My favorite is the agatized, intricately patterned wood that, in one piece, might reveal black, white, and a spectrum of browns, yellows and grays. We collected along this spur road on two separate days and found fine specimens on both occasions.

Good specimens of petrified wood can be found either by surface gleaning or by digging. The two who had been skunked at Airport were both rewarded with large pieces after a few hours of digging at this site. For those less able or energetic, it seemed to me that better pieces found on or close to the surface were located some distance from the road and the heavily dug or previously worked areas. Petrified wood crops out of the hillside at various widespread locations and, with the aid of gravity, water and wind, it has been dispersed throughout the slopes and gullies, far from its original source. I feel that concentrations of petrified wood are still waiting to be exposed and discovered in this area.

continued on next page

Carnival, purple and snakeskin agate specimens were found along the McDermit loop, while the multicolored rhyolite was found in the Cordero Mine tailings.

McDermit *from page 81*

In addition to the petrified wood, the area produced several nice pieces of carnival agate, suitable for cutting and polishing. This agate displays hues of orange to red dotted with black dendritelike inclusions and is laced with clear bands of quartz.

After lunch, we returned to the main road and continued northwest another 5.1 miles. We turned right and drove 0.9 mile past two large tailings piles on the left and an abandoned pit on the right to an intersection, where we turned left and went another 0.6 mile. We were in the center of the "Cary Green" jasper collecting area. There is an abundance of material. Much of it is pitted, unsuitable for cutting; however, careful searching yields solid pieces suitable for lapidary work. The blue-green shades and lines on this rock make it beautiful and unique. At the end of the day, everyone was tired, but very happy with his or her finds.

Bernie and Winnie Paris have been exploring McDermit for more than 20 years and were kind enough to lead the way on this part of the excursion, sharing their experience and knowledge with a new generation of rock lovers.

On Sunday morning, we gathered and headed west, high into the remote vastness and harsh beauty of the hills, depressions, drainages, and mountains of the high desert surrounding McDermit. Instead of taking a right turn at the fork to Cottonwood Campground, we continued straight, following the main road. Our destination was a deserted quarry, and the rock found there is a patterned rhyolite called "chicken track."

This is an unusual rock, almost a novelty. Most rock enthusiasts who attend shows have probably come across it at least once. The surface of the rock is haphazardly crisscrossed by raised tracks of what looks like hardened yellow mud. In miniature, it reminds me of vole castings left on the surface of the ground after the snow melts in spring. Primarily, it is used as a landscaping material, making beautiful stepping stones. Dana has also incorporated it into a rock wall she is building. Beneath the tracks, there is a 1- to 2-inch-thick layer of solid rock. Similar to picture jasper, this rhyolite sometimes displays images along its sides and is dense enough to be cut and polished for lapidary purposes.

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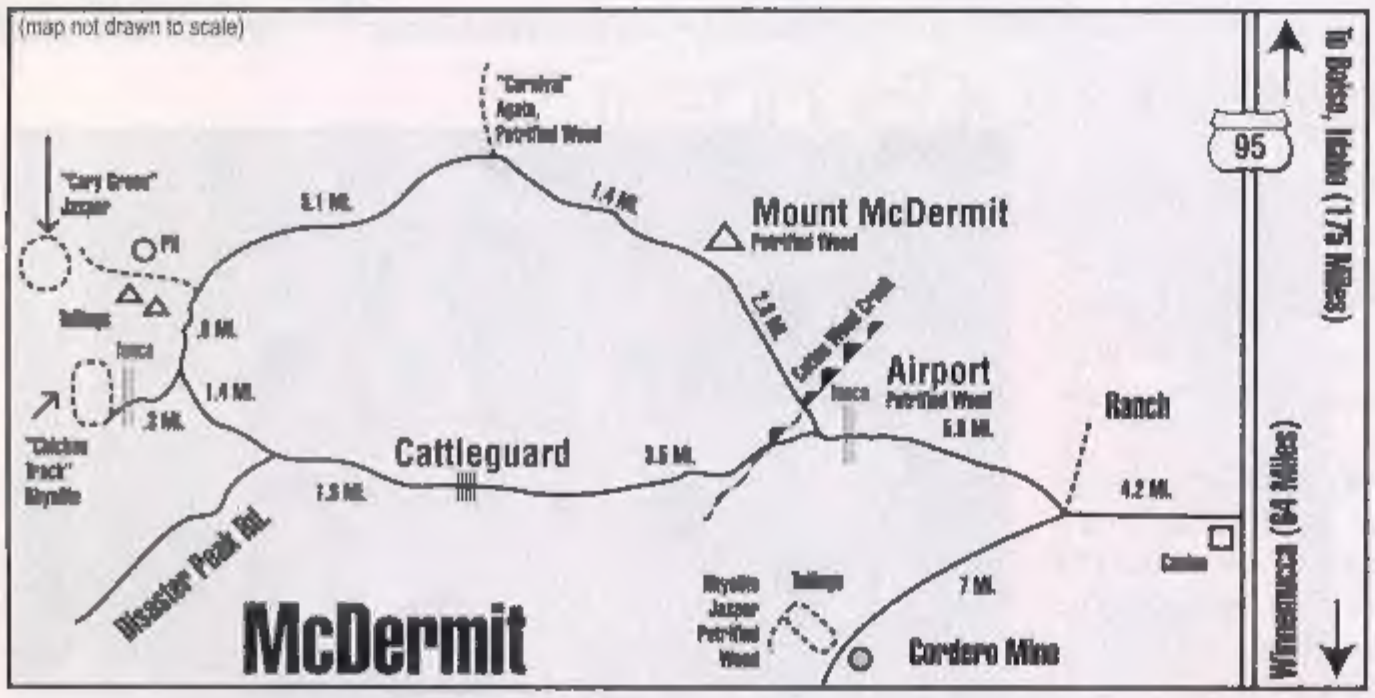

At the site, everyone started using rock picks and other tools to turn over pale-yellow slabs of weathered rock that appear fairly ordinary on the surface. After a few tries, we were rewarded with pieces that display some of the best chicken track I have ever seen. The chicken track is damp when freshly turned over, and the tracks tend to crumble if it is not dried before cleaning. Bernie said it would harden after drying, and it does. The chicken track should be packed carefully for the ride home.

Our second stop that Sunday was at a picture jasper site, but we did not find much good lapidary material. Most of the picture rock was too porous and soft to be used for lapidary applications. The area looked heavily worked over, probably commercially. Dana found a few pieces of nice, hard picture jasper that had been cut on one side. These pieces were someone else's leavings, so I can only imagine how beautiful the rock they took with them must have been.

Four of us hiked to the gully below. We saw a beautiful 3-foot-long rattlesnake and watched him slide off into the chaparral. One person found a 6-inch-long section of pink limb cast. True to form, McDermit produced an excellent specimen in an area that has been searched for years. This piece was found maybe a half-mile from where the vehicles were parked and seemed to confirm the theory that the farther you hike, the better chance you have of finding a good display specimen.

After lunch, we left the picture rock site and drove east a short distance past the Zimmerman Ranch to search for petrified wood. The area close to where we parked was well picked over. We spread out and spent about two hours scouring the vicinity. Very little wood was found within an eighth of a mile of the parked vehicles.

Having meandered across the flats and down into the wash without success, I made my way up the ridge on the opposite side to a distant white pile of diggings. There was some opalized wood scattered about the pit. Most of it was quite fractured, so I continued along the ridge, occasionally seeing signs of petrified wood. About 200 yards from the pit, there appeared to be a fresh exposure, and I began lifting edges with a rock pick. Most of the material was country rock, but in a short time, I did find several nice pieces of petrified wood. This area of the ridge and farther to the east seems relatively undisturbed and promising. I ran out of time that afternoon and will perhaps make this half-mile or so excursion along the ridge again at some future time.

Special Publication 4 of the Nevada Bureau of Mines and Geology identifies the area around the town of McDermit as a probable caldera. It is about 25 miles in diameter. This regional volcanism, which occurred between 6 million and 17 million years ago, and its associated distribution of ash and mudflows and air-fall tuffs explain the scattered concentrations of petrified wood at various locations in the caldera. In trying to imagine this process, I am reminded of the massive ash flows and mudflows of Mount Saint Helens as it erupted, snapping trees like kindling and sweeping forests off its slopes, and burying their remains beneath a thick layer of debris.

On Monday morning, we made the short drive to the Cordero Mine. This recently reopened cinnabar mine had been abandoned since 1989 and was not operating during our visit. While the tailings are accessible, the area in and around the pit is dangerous and closed to the public. Though it was known for fine specimens of agate, opal, rhyolite, and petrified wood, we did not find much material in the tailings.

Wednesday morning found us back at the first petrified wood and agate site we had been to on Saturday. Our second visit was just as productive as the first. In the afternoon, we headed to a hot spring north of town. The hot spring is situated on a low bluff overlooking a wide depression and a mountain range several miles to the west. With water from the hot spring coursing by and marsh birds flitting about in the high grasses below, the scene was picturesque. Several of the group elected to relax in the breeze under the shade of canopies that they had erected. Others explored the white flats and slopes in the vicinity of the spring. The water is too hot to swim in and there is not much interesting collecting material nearby.

Dana did find a few pieces of Blue Mountain agate containing shades of green-blue and ochre. There is a private claim not far from the hot spring where, with permission from the owner, you can collect this interesting rock. The land around McDermit is harsh, and it makes sense that the bird-rich, grassy marshes surrounding the hot spring would attract Native American hunters in their search for food and raw materials. While exploring the flatlands, Dana spotted an obsidian arrowhead and we saw many bits and pieces of more arrowheads.

Thursday was our last day of rockhounding in the McDermit area. For the past few days, Roy had been trying to get a map and permission to collect thunder eggs on a ranch to the east of town, and that morning he had finally been successful. We drove east across the basin almost directly opposite from Disaster Peak and the hills we had been collecting in for the past week.

In a straight line, we were no more than 10 or 15 miles from McDermit, but it had taken us close to two hours to get there. Our circuitous travels were rewarded when Roy stopped one final time in a field of thunder eggs. Everywhere you looked, there were brown nodules. The average size of the thunder eggs is about 1 to 2 inches in diameter. They are not large, but when cut open, an intricate pattern of colors is exposed. There is usually a small, shallow, botryoidal cavity surrounded by tiny bands of clear, white, red, and yellow agate. The bands closer to the cavity are dendritic. Sometimes, two or more thunder eggs are conjoined, and these are even more interesting pieces. If anyone is interested in visiting this site, or is unfamiliar with the McDermit area, I recommend you contact Ilyssa Fogel, owner of the Diamond A Motel, at (775) 532-8551 or rocks@diamondamotel.com. She offers rockhounds who stay a discount and also provides a free map to the main collecting places.